AMATEUR GUNSMITHING

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NATIONAL RIFLE ASSOCIATION
WASHINGTON, D. C.
1924

CONTENTS

MISCELLANEOUS

FOREWORD

SPORTSMEN often wish to remodel their rifles, shotguns, or pistols. It is seldom that the standard products of our large firearm factories conform in all respects to the ideas of shooters who have given much thought to their weapons. The stock does not fit the owner, the trigger has not just the right pull, stock and forearm need refinishing, or the sights need adjustment and refining.

The majority of American machine-made rifles are equipped with standard stocks which are supposed to fit the average sportsman, but as a matter of fact they don't. If the stock does not fit, the purchaser will find that the cost of a stock to special dimensions is almost prohibitive. The purchaser of a shotgun is more fortunate in this respect, it apparently having been recognized many years ago that men of greatly differing size and conformation might possibly require stocks of different dimensions to do their best work with, so shotgun stocks are usually furnished in a number of dimensions from which a choice can usually be made to meet the dimensions and ideas of the purchaser without extra cost. A correctly fitting stock is really of more importance to the rifleman than to the scatter-gunner, because the life of the former may sometime depend upon a quick and accurate shot, the chance for which is always much better if the weapon fits correctly.

During the last five years riflemen have been coming to realize the value of certain improvements in their favorite weapons, and whereas in former years we seldom saw any alteration in the regular factory product, today if we examine the weapon of an intelligent rifleman or

sportsman we are liable to find a hand-made stock, a checked trigger, a properly designed and adjusted sling strap, a sweet and light trigger pull, and efficient sights with perfect adjustments.

The number of small gunsmiths springing into existence all over the country, who are specializing in this kind of work, is indicative of the demand for it. They charge fancy prices, but in most cases the fine character of the work they turn out is well worth it.

Sportsmen are independent sort of chaps. They like to be efficient. They take just pride in their woodcraft, in being able to care for themselves in any emergency, and in skill with gun, rod, paddle and axe. They like to do things with their own hands, and particularly during the long closed season, when the winter winds whistle past the window of the little den, and outdoors is no fit place for man or beast, they like to tinker with their outfits, getting them ready for next season's use.

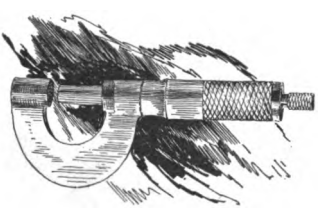
Usually, however, gunsmithing jobs have been considered as beyond the skill of the great majority, and hardly subjects for home treatment. But after watching a number of gunsmiths at work remodelling and repairing rifles and shotguns, I came to the conclusion that their craft was not a gift from the gods, nor one requiring long apprenticeship, but well within the capabilities of anyone willing to take a little pains.

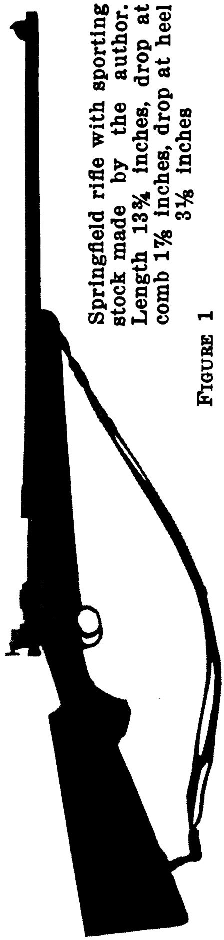
I thereupon determined to attempt remodelling and repairing a few weapons just to see if I could do it, and I found that I could. I had no previous skill, only the ordinary knowledge of rough carpentering that most men have. I was able to do the work successfully in a little 6 x 8 workshop, with an extemporized bench, a small vise, and a very small and most ordinary equipment

of tools. The work I turned out took a lot of time, but it was interesting, and the results were really excellent and comparable with that turned out by our very best professionals.

What I am passing on to sportsmen herein is based on this experience, hence it is both practical and possible. My methods may not be the best, nor even very good ones, but at least they have produced good results. My skill with tools is so meagre that it is my belief that anyone who has only very simple skill with carpenter tools and file can do every bit as well. What is needed is not so much skill as the patience necessary to go slow, take pains, and stick to it.

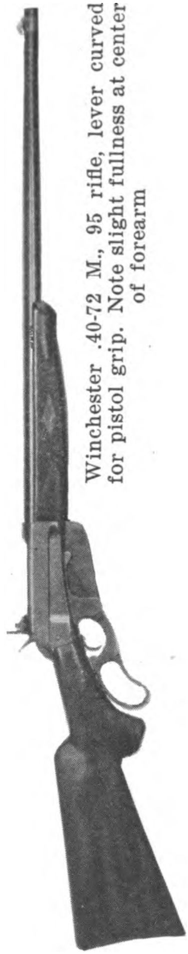
My first real undertaking was the complete remodelling of a Springfield military rifle into a sporting weapon, and I made a complete and huge success of it even if it did take most of my spare time for two months. At a cost of about eight dollars I did a job for which a first-class gunsmith would have charged me approximately one hundred dollars.



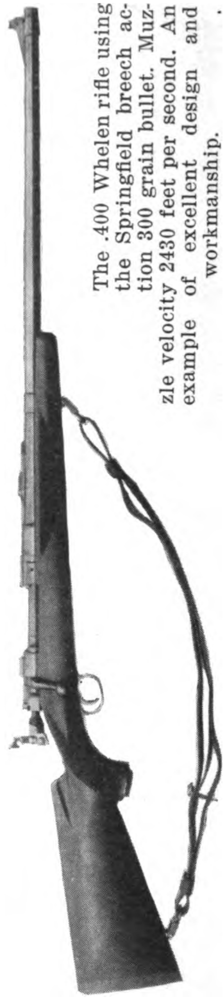


Springfield rifle with sporting stock made by the author. Length 13¾ inches, drop at comb 1⅞ inches, drop at heel 3⅛ inches

FIGURE 1



Winchester .40-72 M., 95 rifle, lever curved for pistol grip. Note slight fullness at center of forearm



The .400 Whelen rifle using the Springfield breech action 300 grain bullet. Muzzle velocity 2430 feet per second. An example of excellent design and workmanship.

CHAPTER I.

Stocking.

PROBABLY the work which most of us will want to attempt first is the restocking of a favorite rifle, or the complete remodelling of a military rifle into sporting type. Such work is usually the most needed, and promises the greatest results for the work entailed. The first thing is to obtain the blank of walnut. English or Circassian walnut is by far the best for gunstocks, but it is practically impossible to obtain it in the United States at present, although the market may get better in a year or two. American walnut is not so hard or well figured, it does not take the fine polish or check that the imported wood will, and it is not so strong so that stocks made of it have to be a little heavier, particularly in the grip, than the best imported models. Nevertheless, a very fine and satisfactory stock can be made from American walnut. There are several dealers in American walnut stock blanks, and their advertisements can usually be found in several of our sporting magazines. * Good blanks sell at from three to six dollars each. The ordinary shotgun blank is suitable for rifles like lever action models which have the stock and forearm in separate pieces. Long military pattern blanks should be obtained for bolt action rifles. If separate stock and forearm are to be made, purchase the blank for the forearm at the same time that you get the stock blank, and specify that both shall have the same color, density, figure, and grain, so that they will match when completed and polished. Specify in order of importance straight grain at the grip running parallel with the same, absence of

* Among dealers in walnut stock blanks may be mentioned C. T. Harner, 117 N. Isabella St., Springfield, Ohio, and R. D. Tait, Montague, Calif.

checks, splits and holes, dense grain, no soft places, good figure, curly grain in the butt. The blank should be a full two inches wide, and of sufficient size to easily lay off on it the stock of the full dimensions and shape desired. Better send a paper sketch outline drawn to scale with your order, and for safety sake make your sketch at least ¼-inch larger than desired all around.

Having obtained the walnut, all the necessary metal work should be done on the rifle before beginning on the wood. If necessary the barrel should be turned down, and polished, but not necessarily blued. If it is a military rifle that is to be remodelled the rear sight fixed base usually has to be removed before the barrel is polished. Forearm screws should be fitted, trigger checked, sling swivels made, the desired type of buttplate obtained or made, all screws made or procured, etc. The details of this metal work will be covered later.

The tools absolutely necessary for the making of the stock are as follows:

Carpenter's bench with vise.
Saws, cross cut, rip, and compass.
Mallet.
Planes, 15-inch and 4-inch.
Draw-knife.
Spoke-shave with cylindrical body.
Brace with assortment of bits.
Chisels, ¼", ½", and ⅛".
Gouges or half-round chisels, ½" and ¼".
Files, half-round, large and small.
Rasp, half-round, large.
Checking tool.
Screwdrivers, large and small.
Sandpaper, coarse, medium and fine.
Crocus cloth.
Mechanics blue, tube or can.

Many other tools would come in handy, but the above are all that are absolutely necessary.

The following details of work are based on the making of a sporting stock for a Springfield military rifle

(U. S. Rifle, calibre .30, Model of 1903), the actual rifle produced being shown in Fig. 1, but the principles entailed will answer for any type of stock. It will help greatly if the old stock is at hand to copy from as to cuts for receiver, trigger guard, tangs, etc., but if not dimensions can always be taken from the metal parts and laid off on the wood. It also assists if one has a remodelled rifle, even if it is only slightly similar to the one he proposes to reproduce, to follow in outline. In the absence of such a model use the accompanying illustrations of remodelled rifles as guides, but do not follow them too closely unless they are exactly the type that you want. The best stock for you is the one which conforms exactly to your ideas and expresses your own individuality. This is one of the advantages of making your stock yourself. You get it exactly as *you* want it, and not as some hide-bound gunsmith thinks it ought to be.

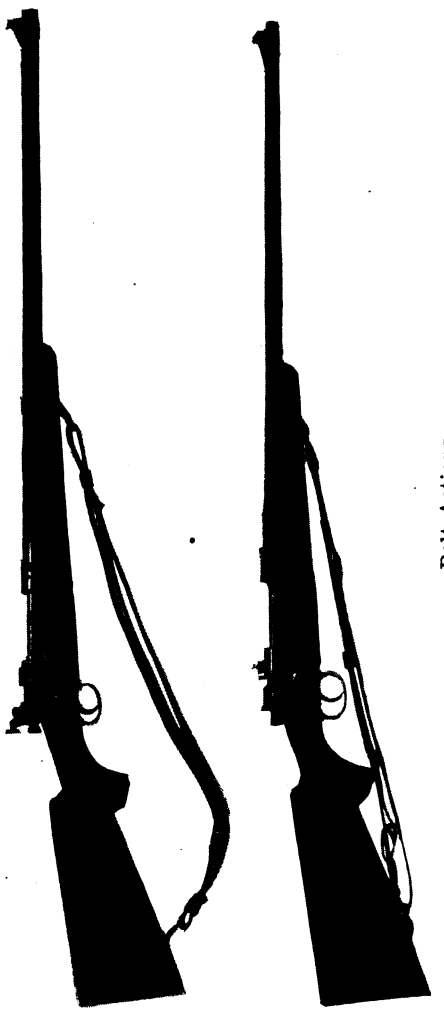
Decide on the length, drop, and other dimensions of stock you want. Most factory stocks have not drop enough and are not long enough. The best way to determine dimensions is to try a number of rifles with varying sizes and shapes of stocks until one is found which seems to fit just right, and which comes up to the shoulder easily and naturally, and so that the sights are accurately aligned on the target without any change of position being necessary after the first throw up. But this method of obtaining the correct size is manifestly impossible for most of us as the weapons from which to make the selection will not be at hand. Years of experience in fitting stocks to a great many sportsmen, and watching such men try the great number of rifles in my armory, has shown that the following dimensions are almost always correct for the average American

Examples of Special Stocking.

Lever Actions.

Above: Winchester single shot rifle, caliber .30-40, with special stock and pistol grip-cap of mountain sheep head in bronze by Deming, the painter of Indians.

Below: Winchester Model '86 rifle, caliber .33 W. C. F., with special stock and forearm to completely hide magazine.



Bolt Actions.

Above: Springfield special match rifle with heavy 28-inch barrel; pistol grip stock. Very accurate. Weight, 10½ lbs.

Below: What can be accomplished with a military weapon. A captured Mauser action, restocked to Whelen pattern and fitted with a new .25 caliber barrel.

Examples of Special Stocking.

sportsman, that is the man of 5 feet 6 inches to 5 feet 10 inches tall, not too stout, and with correctly proportioned neck and arms:

Length, middle of trigger to middle of butt-plate.....13⅛ inches
Drop at comb from line of sight..... 1⅞ inches
Drop at heel from line of sight..... 3⅛ inches

These dimensions are for hunting rifles, that is, for rifles with which 85 per cent of the shooting will be in the standing position, 10 per cent in the sitting or kneeling position, and about 5 per cent in the prone position. If the rifle is intended to be used almost entirely for target shooting in the military prone position, then the best dimensions for the American of average stature and proportions are:

Length, middle of trigger to middle of butt-plate.....13¼ inches
Drop at comb from line of sight..... 1¾ inches
Drop at heel from line of sight..... 2½ inches

The butt-plate on this prone stock had best be placed at right angles to the axis of the bore, that is, with little or no pitch. The Springfield stock as issued has entirely too much drop at both comb and heel, and is entirely too short.

A long neck requires a greater drop, some men requiring as much as 4 inches at heel, but practically never any more than this. Men of short stature and with short arms require short stocks, but almost never less than 13 inches. Stout men require shorter stocks. Stature has little to do with the drop at the comb. This measurement depends largely on the conformation of the cheek and cheek bone. Men with lean faces require thicker combs than those having full faces. If a marksman has a high cheek bone it behooves him to experiment a little with a rough stock to find the correct shape and height that will give support, lead the eye

quickly and surely into the line of sight, and yet not give him a thump in the cheek bone every time the rifle recoils. A drop of 1¾ to 1⅞ inches will be found about right for all types of stock for the average man when using metallic sights. Telescope sights require very high combs, and it is usually best to make a removable high comb to fit on top of the regular comb with two steel dowel pins. Often in working on the stock it is more convenient to take the measurements from the axis of the bore to the comb and heel—simply measure the distance from axis of bore to top of front sight and deduct from above. To lay off drop at comb and heel from the axis of the bore, insert a straight steel cleaning rod and patch from the breech, allowing the rod to project as far to the rear as the butt of the stock. Ream out the primer pocket and flash hole of a cartridge case to the diameter of the cleaning rod, and slip down over the cleaning rod to the chamber. The rod will then prolong the axis of the bore as accurately as is necessary. In making the measurements allow for half the diameter of the rod.

Refer now to Fig. 2, which is a side view of the rough stock blank. Lay off the pattern of the stock on the side of the blank as shown by the dotted lines, but be generous and allow plenty of margin all around. Establish the line A-C very accurately, however, this line being the top surface of the forearm, parallel to and level with the axis of the bore. Plane off the edge of the blank on this line A-C accurately, smoothly, level, and true, using a large square to true it up as you plane. The barrel and receiver are to be let into this surface so that the barrel will be just half imbedded in it, and as the surface will be one of the final surfaces of the finished stock it must be guarded throughout the work from

dents and scratches. *Do not do any more shaping up of the stock at this time,* but keep the blank and its edges square as long as possible. All the metal parts—barrel, receiver, guard, tangs, magazine, butt-plate—are to be let in accurately before starting to shape the stock or to do any work on the sides of the blank.

Next draw a center line, heavily and accurately, completely around the edges and ends of the blank. If your blank is 2 inches thick this line will be just an inch from each side surface. Preserve this center line while you work, renewing it from time to time if it gets dim. This is necessary to keep everything in line—barrel, receiver, comb, heel, butt-plate, pistol grip cap, trigger guard, holes through the stock, etc. The barrel and receiver are to be let in first, then the guard and magazine, the butt-plate is to be fitted, the wood cut down to the correct point at comb and heel, and the pistol grip cap located, each operation being completed in turn before proceeding to the next, and all this is to be completed before the stock is shaped up at all or the sides of the blank touched.

Take the barrel and receiver first. Measure carefully with calipers and accurate steel rule all the cross dimensions and lengths for each different cut, and mark the outline plainly on the planed surface A-C (Fig. 2). It helps a lot here to have the old stock set up alongside the work, and to follow it closely. In fact, it will help to do this all along throughout the whole operation of letting the metal parts into the wood. After laying out all cuts, bore a string of ¾-inch holes through the blank from top to bottom inside the magazine mark. This starts the cut of the recess where the magazine will lie, and gets a lot of wood out of your road. In boring

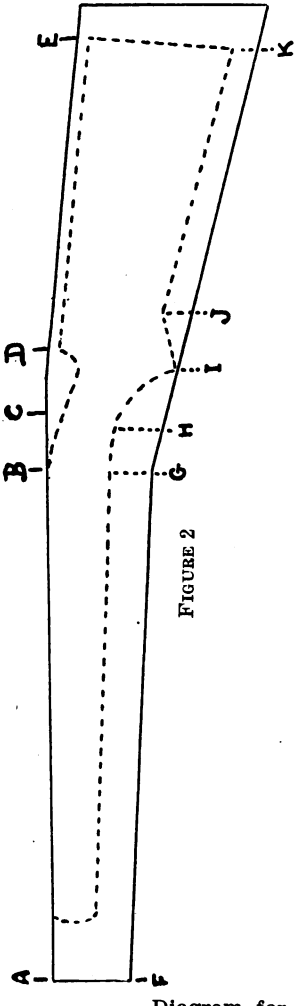


FIGURE 2

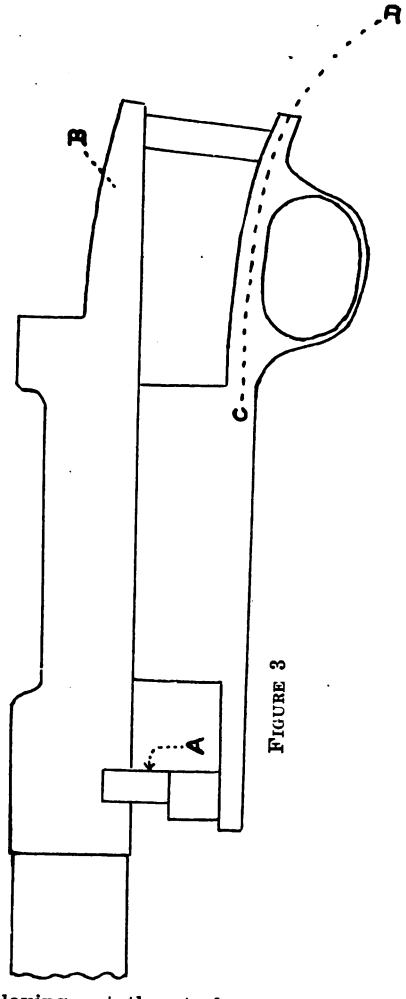


FIGURE 3

Diagram for laying out the stock.

these holes be sure to get them straight so that their centers will strike the center line on both the top and bottom edges of the blank. Then cut between the holes with a sharp chisel. Proceed to cut out the barrel channel and bed for the receiver, using the gouges and chisels, and keeping them very sharp. At first do not cut within 1/32 inch of the outside lines marking the various cut. Proceed slowly, line the work up constantly, and fit the barrel and receiver to the work every few minutes to see that all is going correctly. You will usually find that the grain of the wood is such that you can gouge and chisel in one direction only, working in the opposite direction tending to split the wood. Also you will probably have different working directions in various parts of the wood.

In doing this rough cutting, particularly if one is making more than one stock for a certain type of rifle, it will facilitate matters considerably if a series of gauges shaped like Fig. 3-A cut out of tin, one for each two or three inches of the barrel from the receiver forward. Put cross lines on the stock at the spots corresponding to the gauges. Make the gauges 1/16 inch smaller, or less in diameter, than the barrel at the point they correspond to. These are to be used as quick guides in getting the barrel channel roughed out, and make it unnecessary to go through the rather tedious operation of bluing and fitting the barrel so often while making the rough cuts. This matter of trial gauges can also sometimes be extended to certain cuts in the receiver.

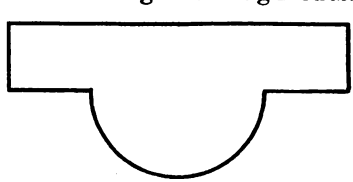


FIGURE 3-A

When you get the wood cut away to within about

1/16 inch of what you think is correct you must proceed very carefully and slowly, with frequent trial fittings of the barrel and receiver. Rub the under surfaces and contact points of barrel and receiver with the mechanics' blue, carefully let the barrel and receiver into place, lowering them down straight and parallel, and then carefully lift them straight out again. The wood at the points of contact will then be marked with blue spots. Cut off these marks lightly with gouge and chisel, and again let the blued barrel and receiver in, continuing to shave off the wood at the blued spots until the barrel and receiver sink to their proper bed in the wood and fit perfectly, not only at the edges, but over their entire surface of contact. As they get almost to the depth required proceed very slowly, taking off only about a paper thickness at the blued spots. Every time that you seat the barrel and receiver in the blank look at them from every angle to be sure that they are going in straight and level. Be sure that they do not cant or lean as they go in. If you find any tendency in this direction as the work progresses, forcibly straighten them up after you have pressed them home. Of course, you cannot do it completely, but this will cause the blue marks to appear heavier and more frequently on the very parts that you should cut away most to straighten the work up, and by cutting here the work will gradually straighten up itself. Little rectifications like this are needed from time to time as you proceed. Do not let the mechanics' blue gather in a thick mass on the steel portions. Keep it thin with oil, and wipe it off when necessary with oil or gasoline. Do not let it get smeared over the wood, but keep the wood as clean as possible. If it is used right there will be only a few contact points show each time on the wood, and these are immediately shaved off.

On the under and forward portions of the receivers of Springfield and Mauser rifles is a projection shown at A in Fig. 3. This is the recoil shoulder and holds the whole barrel and receiver forward in the stock against the recoil. It is very necessary that the rear surface of this projection bear snugly and accurately against its shoulder in the stock, otherwise when you have the whole rifle completely finished you may find that the receiver gradually drives to the rear as the weapon is fired until the wedge-like tang portion at the rear of the receiver (B in Fig. 3) splits the stock at the grip. Look specially to the fit of this metal projection against the forward surface of its shoulder in the stock.

As you let in at the rear of the receiver you will gradually have to cut and round down the top surface of the wood between B and C (Fig. 2) to follow the upper surface of the upper tang in rear of the receiver bridge. Do not overdo this but go slowly, cutting down no more than is necessary to enable you to accurately maintain the fit of the edges of the cut in the blank. Fit well around the cut-off of the receiver, keeping the cut-off turned up (ON), and do not make the cut for the cut-off in its down position (OFF) until the stock is completely shaped up, as there is danger of splitting here when shaping up the stock. Fig. 4 shows appearance of stock at this stage.

After the barrel and receiver have been completely and accurately let in so that the barrel is imbedded just half its diameter in the blank, the next operation is to mark and drill the holes for the guard screws which connect the receiver and trigger guard. Make two small steel plugs just large enough to enter the screw holes in the receiver and extend about one-sixteenth inch.

Sharpen these plugs at one end so that when they are inserted in the guard screw holes they will be just friction tight, and will project about one-sixteenth inch in the shape of a sharp point which is the center of the screw hole. Now, if the receiver be carefully settled home in the stock these plugs will punch mark the bed of the receiver in the stock at just the point to start the drill for the guard screws. Unless one has access to a machine shop and drill press it is quite a little job to get these guard screw holes drilled accurately. They must, of course, be accurately drilled so that the receiver is not twisted to either side nor forced backward or forward when they are tightened. They must be tightened very tight with the completed rifle or the shooting will be ragged. The forward screw hole is perpendicular to the barrel and receiver, but on the Springfield rifle the rear guard screw goes in with a little slant forward at its lower end, and this must be allowed for in drilling the hole. Also this rear hole should be drilled correct size for the rear guard screw bushing and not for the screw itself. If you have no drill press on the bed of which the stock blank can be accurately set up, it is perhaps safest and best to drill the holes very small at first, and then to enlarge them, and get them in perfect line, with a very small rat-tail file.

It also sometimes assists materially in boring these holes to line the holes in in pencil on the sides of the stock directly alongside and parallel to where the holes should be, and at the proper angle. Then, while drilling, if one will step to one side, and to front and rear of the work, he can line the drill up with these lines, and keep the drill truly vertical with respect to the sides of

the stock. Do not slight this job, but take a couple of evenings at it if necessary to get these holes correct.

Next you want two headless screws, similar to the two guard screws, but about one inch longer. These are to be screwed into their holes in the receiver, the receiver put in its bed in the stock, and secured there by wrapping with heavy cord, so that the headless screws will extend through the guard screw holes in the stock and project almost an inch below the bottom of the stock. You are now ready to let in the guard, including the trigger guard and magazine. Run this guard up to its approximate position on the stock by using the projecting dummy guard screws as guides as shown in Fig. 5. Mark about the outside lines of where the cuts will be, and start the cutting for the bed of the guard, first letting in the walls of the magazine. Each time in letting the guard up to the wood be sure that it comes up parallel in proper relation to the receiver, and that it does not slant to the front or rear. Also be very careful not to get the recess for the magazine portion of the guard cut out too long at first or you will have bad vacant holes showing at the forward and rear ends of the magazine when the stock is finally completed and all the parts assembled. Use mechanics blue constantly. Gradually the bed for the guard is hollowed out, the guard being lowered each time using the dummy guard screws as guides so that it finally comes into exact position with relation to the receiver, and it is only necessary to replace the dummy screws with the regular screws to secure the guard to the receiver with perfect fitting of the wood everywhere. Note particularly in cutting away the surfaces of the wood just outside the

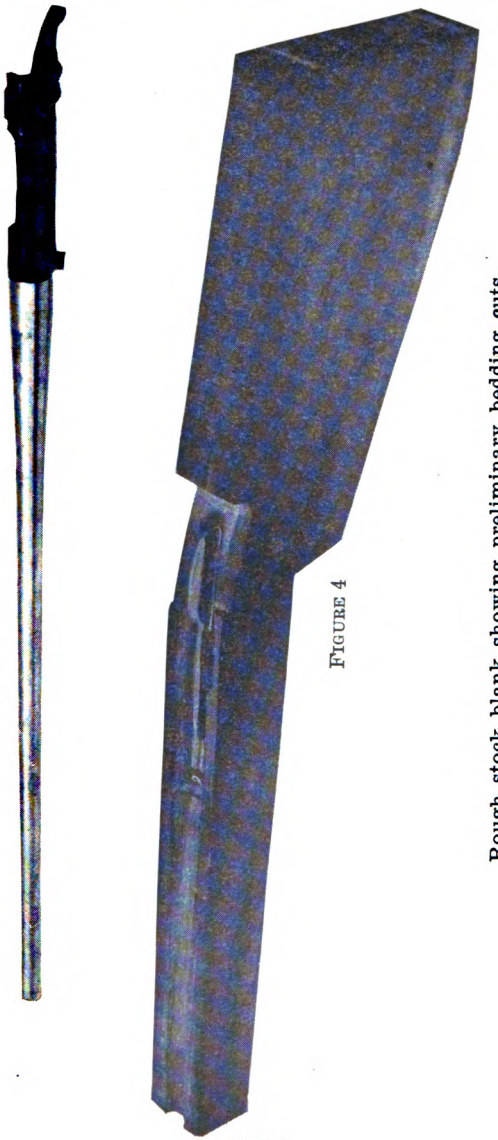


FIGURE 4

Rough stock blank showing preliminary bedding cuts.

guard that the downward curve of the receiver really starts at the rear of the trigger guard, and not at the rear of the lower tang, and do not cut away the stock so much here that you can not get the proper curve for the pistol grip. See where the curve of the pistol grip starts in Figure 3.

Screw the barrel and receiver tight to the stock, insert the cleaning rod, patch, and drilled cartridge case in the bore as described above, and measure down to the comb and heel to obtain the proper drop of stock at these points. Then carefully cut the comb and heel down to these dimensions. Locate the point of the comb usually just above the center of the pistol grip cap. When these portions have been cut down as shown in the figure, the center line will still be on the raised edge of the stock between the two cuts, and this center line can again be marked on the top of these comb and heel cuts, thus preserving it and enabling you to afterwards line up the top of the stock and the butt-plate central with the remainder of the work. Then cut off the raised portion of wood between these comb and heel cuts, thus getting to the true and final surface of the stock between comb and heel. Again replace the center line by drawing a straight line between the center marks at comb and heel. You are now ready to fit the butt-plate.

First saw and rasp an approximately correct surface at the butt of the stock to receive the butt-plate, but make this rough cut about one-eighth-inch longer than the final length dimension of the stock. Then coat the under surface of the butt-plate with mechanics blue and fit up, using the file and chisel if necessary. In filing across the grain, take care that the file does not rip off

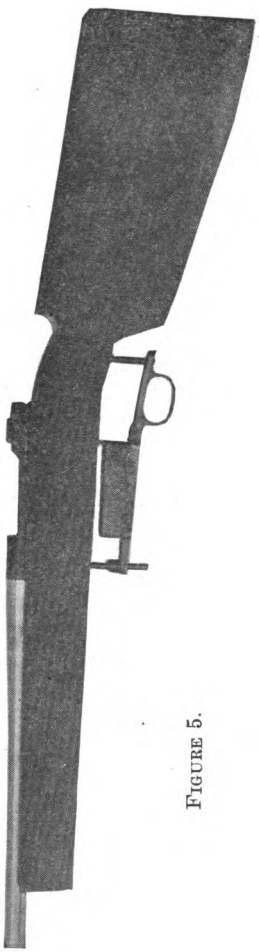


FIGURE 5.

Rough stock blank with barrel and receiver bedded and pistol grip roughed out, showing set-up preparatory to bedding trigger guard and magazine well.

small chips from the side of the stock just at the edges where the butt-plate will come.

The butt-plate should be fitted at such an angle that when the butt-plate is resting evenly on the ground the barrel will slope forward or downward at the muzzle about three inches out of the perpendicular. This is what is termed "pitch," and this pitch enables the butt to be placed against the shoulder without catching, and helps to keep it in place against the shoulder when the mechanism is worked in rapid fire.

This makes the toe of the butt-plate come a little nearer to the trigger than the heel does. Sometimes it is desired to give the butt a little cast-off, that is, to mount the butt-plate a little to the right of the center line so as to throw the whole butt-stock tighter against the cheek in aiming. The usual cast off is from one-eighth to one-quarter inch at the heel, and from one-quarter to three-eighths inch at the toe of the butt-plate. Of course, the cast off for a left-handed shooter should be to the left. A stout-faced man does not require any cast off as a usual thing. It is better not to put it on unless you feel a real necessity for it. It really results in the whole of the butt-stock being slightly twisted outward from the shoulder.

Having fitted the butt-plate, next shape up the outline of edge of the pistol grip, locate its cap, and if you are to have a separate cap of metal or hard rubber fit this in place and secure it. The pistol grip cap is usually located at a point so that the center of the cap will be from $3\frac{3}{16}$ to $4\frac{1}{8}$ inches from the center of the bow of the trigger (front surface where finger touches). A man who squeezes the trigger with the first joint of his forefinger will usually prefer the cap of the pistol grip a little further to the rear than one who squeezes

with the second joint. Also, the length of the stock has some bearing on this dimension. A pistol grip pushed well to the front will make the stock feel longer than it really is, and vice versa. The distance that the cap extends below the general lower line of the stock (from guard to toe), and the angle at which the cap is placed on the grip, depend on the ideas of the rifleman. It is thought that the cuts of remodelled rifles shown herewith give a good guide as to length and angle. Then cut the stock to its final line between the pistol grip cap and the toe of the butt-plate. Finally shape up the forearm in outline.

Up to this point you have not touched the sides of the stock at all. It should now be in perfect outline, but should be just two inches thick everywhere, with perfectly square edges. By maintaining it in this way, up to this point, you were able to get everything level and square, you could keep things much straighter with the eye, and the stock blank fitted perfectly in the vise. You did not have to take any pains to prevent disfiguring the sides of the stock. Now you are ready to shape it up.

In shaping up the stock it is always best to have a finished stock right alongside of you to use as a model in getting the right lines and shape. A sporting stock of a bolt action rifle may not often be available for a model, in which case, just an ordinary shotgun stock with full pistol grip will give you a lot of assistance. Of course, you will make such changes from the shape and contour of your model as your ideas dictate. A rifle stock should be chunkier and heavier than the ordinary shotgun stock as it is called upon to stand harder knocks. Particularly it should be thick in the grip, as thick and strong as your hand can stand and

still not have it feel clumsy. In this shaping up your work will be very like that of a sculptor.

Start in with the draw-knife, and take off the bulk of the wood not needed, particularly on the sides of the butt, and the under side of the forearm. If much wood has to be taken off, it may be quicker and safer to use the rip saw. Round up the top and bottom of the butt-stock and the bottom of the forearm slightly. Always work with the draw-knife in such direction that the wood will not split or rip as you make the cuts. Do not carry the work with the draw-knife too far. It is a rather dangerous tool and you are liable to make a cut too deep and thus spoil the whole stock after you have worked days on it. Better lay it aside entirely after you have roughed out just a little, and then work the stock down to almost the dimensions and size required with the rasp. Finally finish off smooth with the file, trying the metal parts often. Line the work up repeatedly, looking at it from all directions in good light to see that the lines and curves on both sides of the stock are the same and that it is shaping up just as you want it. Continue with the file until the stock is practically finished, and until the surface is level to within about the thickness of about three sheets of paper with the metal parts, this to allow for the little working down when sandpapering.

Now go all over the surface with coarse sandpaper until all file marks are removed, and then once more with medium grade sandpaper. Now is the time to make the cuts for and fit the sling swivels and the band which secures the barrel to the forward part of the fore-arm. Also make the cut for the cut-off in its turned down position.

We are now ready for finishing up the surface of the stock preparatory to checking and polishing. Take a wet rag and thoroughly wet all the surface of the wood, and then hold it over a gas burner or stove to dry fairly quickly, but not so close as to scorch. This will cause the grain to raise all over with a rough, fuzzy surface. Sandpaper the raised grain off smooth with medium grade sandpaper; then wet, dry, and sandpaper again and again until after wetting and drying, the grain does not raise a particle. Usually about six wettings will be required. Then go all over with fine grain sandpaper, and finally with crocus cloth, and you will have a fine smooth surface, the grain of which will not raise up when you are caught out in a rain.

In certain locations on the stock the sandpaper can often be used very effectively by fastening the stock in the vise and pulling the sandpaper over the curved surfaces in much the same manner that the boot black uses his polishing cloth. At this stage of the game, whenever you use the vise, be sure that the jaws are padded with leather, or they may mark the stock too deeply to be removed by sandpapering. For the same reason, in handling the stock around the bench, be careful that you do not knock it against objects, particularly metal objects.

Stocks for shotguns and for rifles which have the butt-stock and forearm separate, are made on the same general principles as the stocks for bolt action rifles. First, lay out the work with great care, seeing particularly that the surface of the wood into which the upper tang is to be let is at the correct angle with the

rest of the blank so that when fitted to tang and receiver you will be able to get the drop of stock at the heel that you want. It is very easy, but not letting the tang in at just the right angle, to have the stock finally come to high or too low at the butt so that you can not get the right drop. Watch for this.

It is easier to let in the upper tang only at first, but on some guns and rifles the lower tang can not be detached from the receiver, and both tangs have to be let in together. First draw your center line completely around the edges of the blank as described in preparing the blank for starting the bolt action stock. Make the cut for the surface into which the upper tang is to be let, taking the precautions detailed above. Reproduce the center line again on this surface, and then lay off on this surface the outline for the upper tang cut so that the cut will be perfectly bisected by the center line. Cut out the wood slightly within this outline so as to start the recess for the upper tang, but do not cut to within one-sixteenth inch of the outside lines, leaving the remainder or to be taken out carefully as you let the tangs in and are guided in your cutting by the mechanics blue with which you have coated the tangs and receiver. Similarly make the cut for the under grip surface where you will let the under tang in, and start the recess for this under tang in exactly the same manner.

Now you are ready to fit the tangs and receiver up to the wood, and to base all your other cutting on just how they fit each time they are tried. The stock and the receiver and tangs should be brought together gradually by bringing the stock straight forward toward

the receiver, the movement being in line with the barrel. The stock thus moves straight forward, and as the tangs are let in further and further to the rear, the stock will finally reach the rear of the receiver, and you will begin to let the rear end of the receiver into the stock, until finally the tangs are fully seated, and the receiver abuts evenly against the stock. The tangs may get seated pretty deeply, and you gradually cut away the surface around them so you can see that you are getting a good fit between the wood and the sides of the tang, so the wood will perfectly meet the tang.

As the stock moves forward during the fitting you must be careful that the center line on the edges of the blank keeps in line with the barrel, and also that the butt of the blank does not move up or down so that the stock will be crooked with respect to the rifle, or that you can not get the drop at heel that you want.

The letting of the tangs and receiver into a stock of this kind is a job that takes lots of time and extreme care. You must figure it all out in advance, trying to visualize each process so you will not make a mistake. It is best to use a common piece of walnut first and make a practice stock, as you will probably find that your first attempt will be rather crude. The accurate fitting of a stock to the action, receiver, and locks of a double barrelled shotgun is one of the most difficult jobs in gunsmithing. It requires extreme care and also long experience before it can be done in a really first class manner. Some stockers never master it, and confine their work to rifles and repeating shotguns. Experience is the only teacher.

Almost every type of shotgun and rifle requires the fitting to be done just a little differently, so it is not possible to explain the operations in as exact detail as for the Springfield and Mauser rifles, the receivers of which are very similar.

CHAPTER II.

Checking.

THE amateur will often wish to check the grip and forearm on a stock. It may be a stock that he has made according to previous directions, or he may have a rifle with a plain factory stock, the checking of which will improve the looks greatly, and at the same time make the grip of the hands and the holding much more secure. The checking of a grip or forearm is not so difficult as it would seem, and anyone with a little pains, care, and time can master it if he is started off right. No special skill is required other than a good eye and a little practice. The following methods of checking I have worked out myself, practically without assistance, as I have never seen a professional check a stock. The methods work well. They have been tried by some of my friends with excellent results. Of course, at first the results will be rather crude, but after the third or fourth attempt the skill comes, and the results are good enough for the finest weapon and the best of walnut.

The only tools necessary are a checking tool shown in Fig. 6,* and a flexible ruler such as a piece of steel tape or celluloid. The checking tool should be made of a square rod of tool steel about 3/16-inch, and about ten inches long. To one end fit a handle and heat the other end and bend it in a quarter circle, as shown in the cut, slightly flattening the end on which the teeth are to be cut so that it will be about ¼-inch long and ⅛-inch wide. Cut the teeth exactly as shown in Fig. 6,* which also illustrates how *not* to cut them. There are two rows of teeth. The teeth must not be like saw teeth or

*See page 47.

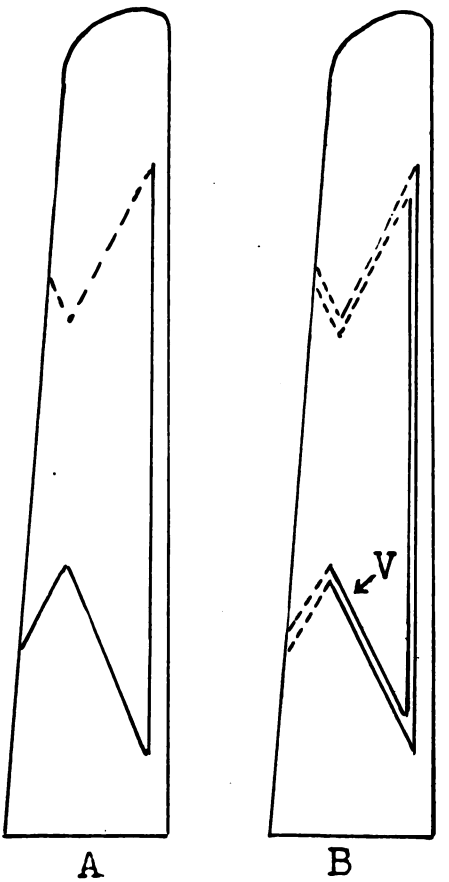


FIGURE 7

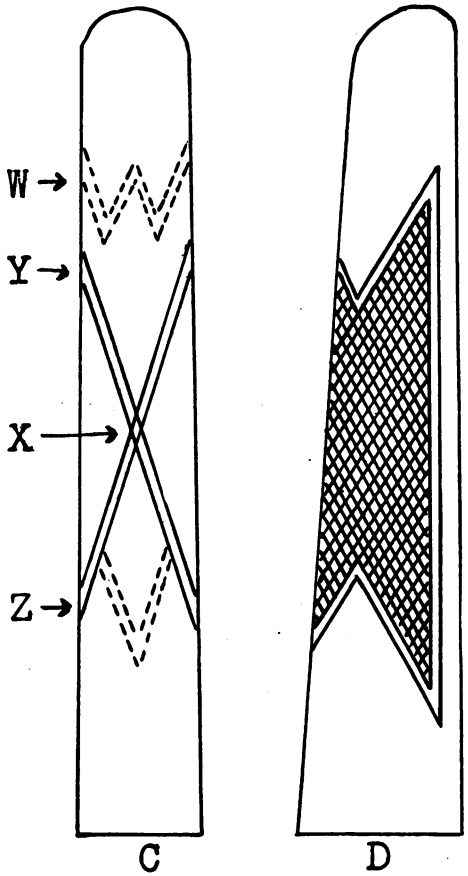


FIGURE 7

they will cut too fast and rip and splinter the work. The cutting of the walnut must be more like filing. Viewed from the front (the cutting edge) the angle between the teeth must be very large, while the angle on the outside of the teeth must be more abrupt. The drawing has been made carefully and shows this clearly. After filing and sharpening the teeth heat the end of the tool to cherry red and plunge into water. Of course, on the distance between the two rows of teeth depends the size of the diamond of your check, so this should be made to suit your own ideas.

Practice on odd pieces of walnut before attempting to work on a stock. It takes a couple of hours to become proficient in cutting the lines straight, and of even slope on each side, so that the diamonds will come out uniform, and the same size. With pencil and flexible ruler rule two lines on the wood, crossing each other at the correct angle to make the diamond desired. The tendency of the beginner is to make diamonds that are too nearly square. The two pencil lines should cross each other so as to make acute angles of about 37 degrees and obtuse angles of about 143 degrees, as this makes the best shaped diamond. Now grasp the tool with the index finger lying just above the curve of the rod. Tilt the tool a little to the right or left so that only the teeth on one side will cut at first. Have the pencil line you are going to cut with in line with the forearm and shank of the tool, and with a straight forward motion cut, or more properly speaking, file a very faint line following the pencil line as exactly as possible. At first, for the first two or three strokes, cut only with the forward motion of the tool. When the cut has appreciable depth you may

cut on both the forward and rear strokes. It is very important to get the first scratch exactly straight, and see that it follows the ruled line perfectly, because the tool will afterwards follow the preceding scratch, and if that be crooked the final line will be crooked, and it will be most difficult to rectify it. Deepen the scratch slightly and evenly with each succeeding stroke, keeping the tool tilted to one side and cutting only one line. when the first groove or line is cut about half the depth required, straighten the tool up slightly so that it will make another scratch alongside the first line and parallel to it. During successive strokes gradually straighten the tool up so that it is cutting deeper and deeper in the second line, until the second line is cut as deep as the first. During this cutting of the second line do not attempt to make the tool cut in the first line, but let the teeth merely run in the first line, this first line forming a guide for the cutting of the second. Do not cut any groove to its full depth at first as you are tilting the tool all the time in cutting one groove after another, and consequently you would not finish them up with an even slope on each side. So far you have been cutting parallel to one of the ruled lines only. After having cut four or five lines in this direction, turn the wood so that the other pencil line is in line with tool and forearm, and start cutting lines in the other direction. After you start on the second line in this direction you will see your diamonds beginning to form. Try to cut all lines uniformly half the depth required. After you have completed the grooves both ways, and covered the entire area to be checked with diamonds, straighten the tool up and go over all the lines a second

time, cutting them to the required depth to fully complete the diamond, giving to it the appearance that pleases you most. During this cutting have a small paint brush, and continually brush the sawdust out of the grooves so you can see that you are getting them to the required uniform depth.

On the second attempt, first make a border around the area you are going to check. Make this of a double line (see Fig. 7-D), and then check inside this border, taking care that the angle lines forming the diamonds come just up to the inner line of the border, but do not cut into the wood between the two border lines. You have to watch this continually. The work is rather a severe strain on the eyes until one is so adept at it that it becomes a matter of feel and not so much eyesight. The work will be seen more distinctly if you will first oil the wood before starting to work, then the freshly cut lines will show up distinctly against the brown of the oil finish. At first do not attempt to work more than an hour at a time to avoid eye strain. When you can make diamonds, borders, and checked areas to suit yourself on a flat surface of walnut, try the same on a rounded surface like a forearm, and when you are perfect at that you are ready to try your first stock.

It is best to check the stock after it has received the filler, and has had two or three coats of oil rubbed in. If your stock is a factory stock that has no checking it is best to remove all the old finish from the stock (which is usually varnish and poor and cheap) and refinish the stock with filler and oil, as already described. To remove old polish and varnish, procure some varnish remover from a paint store, and use this as directed on the can

usually putting several coats on the wood, letting them remain a little while, then rubbing them off. Wash the stock, and sandpaper down as described in Chapter I, repeating this until the grain of the wood no longer rises, before applying the new finish.

When you are ready to attempt checking on a stock you had better start on the forearm first, as it is much easier to check it than a pistol grip. With the flexible ruler lay out the outline or border of the checking that you wish. Be sure that the outline pencil lines are laid so as to form correct diamonds with angles of 37 degrees. and 143 degrees. The border should be a single pencil line which is cut into the double border line with the checking tool. Figure 7-A shows the pencil border line laid out on a forearm. Follow this border line with the checking tool, cutting it about half depth, then straighten up on the tool and cut the second border line inside the first, but cut only the lines of the border shown by the solid lines in Fig. 7-B, leaving the dotted lines to be cut later, or you will get into trouble and you will not come out right at the end of your work. After having cut the two double border lines as shown by the full lines in Fig. 7-B, you are ready to start the diamond lines inside the border. The first of these lines to cut into the area must be the prolongation of the inside angular border line shown at V, Fig. 7-B. This line must be ruled with a pencil until it crosses under the forearm and meets the border line at the other side. Then turn the forearm over and similarly prolong the same "V" line on the other side. These two pencil lines, if they are drawn right, should intersect on the exact bottom of the forearm at the point X, Fig. 7-C.

In drawing pencil lines over a curved surface like a forearm a flexible ruler cannot be used. Instead it is best to use two needles stuck lightly into the walnut with a piece of thread stretched between them. Stick one needle in the point already established, and stretch the thread from that to the new point, being sure that the thread makes the correct angle at both ends. A little compromise at each end may be necessary. Then stick the second needle in lightly at this new point, and stretch the thread tightly between. With this thread as a guide, carefully rule the pencil line.

When you have these pencil lines correct, start in with the tool and cut them, and then cut lines parallel to them, filling in the center of the pattern. The second of these lines cut will form the first diamond on the under side of the forearm, and in the exact center of the pattern as shown at X, Fig. 7-C. As you gradually continue to cut these parallel lines you will work up towards the pencil lines which form the forward portion of your border, shown at W in Fig. 7-C. If you had cut this portion of the border before starting with your diamond lines the chances are that your diamond lines would not meet it accurately, and the job would not look well. Now, however, as you approach it with your diamond lines, you will see that one of these diamond lines will naturally makes the inside one of these border lines, and the next cut will make the outside one, and the border will form up with the diamonds perfectly. Similarly, as you progress, other diamond lines will naturally form the two small angular border lines shown at W and Z, Fig. 7-C, at the front and rear of the pattern and on the bottom of the forearm. Rather a long explanation this,

but as you actually get to do the work you will see, by following these directions carefully, how the whole thing develops so that perfect diamonds are formed everywhere, and how the border lines meet and are in exact line with the diamond lines. Remember at first time over to cut the lines only half depth, and then go over the whole pattern afterwards with checking tool upright, and cut all lines to correct and uniform depth. Hold the work up to the light at different angles, and you will see where you need to go a little deeper or where you need to hold up. Keep the dust brushed out with the paint brush and by blowing.

In checking a pistol grip the procedure is slightly different. Here you should lay out and cut all the double border lines first. See that the angular lines at the front part of the border meet each other at an angle of 37 degrees. Then cut one diamond line across the entire area by prolonging one of the inside angular border lines as shown in Fig. 8-A. With this line as a guide cut all the other diamond lines parallel to it, and then prolong the other inside angular border line as shown in Fig. 8-B. Lastly cut lines parallel to this last-mentioned line, thus forming your diamonds throughout the whole area. Finish the lines to full depth as described for the forearm.

You will find it difficult at first to cut the lines exactly straight and in perfect alignment with the border when working over a curved surface. They tend to curve off in one direction. It is easier to cut these lines by starting the line on the most rounded surface, and working towards the surface which is least rounded or flattest. You must watch the lines closely, constantly lining up the work with your eye, and making the small,

almost infinitesimal allowances and corrections which will keep the lines looking straight as they pass over the rounded surfaces of the stock.

When the checking has been completed go over it with a very light coat of oil, and then examine it carefully. You will usually see places which need a little more cutting or correcting. Then it is sometimes well to go over the entire pattern very lightly with fine steel wool. This polishes up the diamonds and makes them look smoother, but this polishing must be very light, and must not be overdone—just enough to make the whole thing look smooth. Finally polish the checking with linseed oil on a tooth brush, giving a very light coat only, and not allowing any of the oil to remain in bulk in the checks to harden in lumps. Wipe off all surplus oil, and rub in with a clean tooth brush. Repeat this on several days, and the checking is finished.

Sometimes the grip and forearm of stocks are carved with fancy designs. Of course, this requires skill in wood carving, and this is an art that can hardly be gone into here. Every rifleman has his own ideas and tastes of course, and he should follow these tastes in his gunsmithing to get the work just as he wants it. But personally I have never cared for fancy checking or carving on stocks. It looks gaudy and cheap to me. There is enough beauty in a fine, curly, well polished piece of walnut to suit anyone, it would seem. Undoubtedly gunsmithing has reached the highest development, artistically as well as mechanically, in certain of the leading London gun manufacturing houses such as Purdy, Westley Richards, Holland and Holland, and Greener. These firms always confine themselves to plain

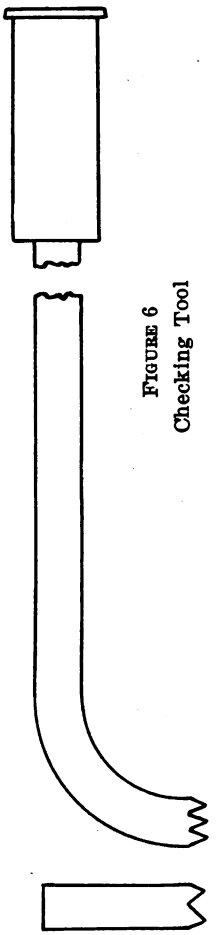


FIGURE 6
Checking Tool

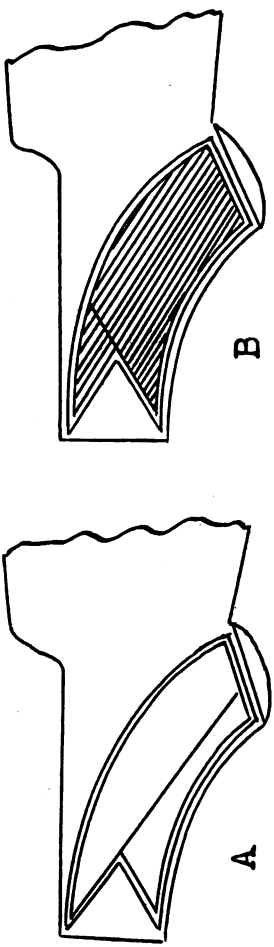
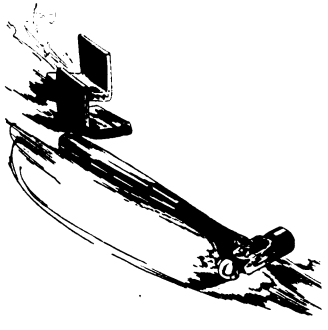


FIGURE 8

checking as shown in the cuts and rifles shown here as illustrations. They do this no matter how elaborately the metal parts of the weapons may be engraved. The German gunsmiths are great hands for carving stocks, but then they always tend towards the gaudy anyhow, and their tastes in art are far different from ours. It is the same taste that makes a German parlor run to bright plush upholstery, heavy draperies, gorgeous lamps, richly carved and varnished furniture, and gold. But everyone to his own tastes. If you like it carve an elephant on the cheek piece, and gild the darn thing.



CHAPTER III.

Polishing Stocks.

IN GENERAL there are two methods of polishing stocks; varnishing and oiling. Oil finish is often called "dull London finish." The varnish finish is usually employed on the cheaper variety of stocks. It has nothing to recommend it except its cheapness and the rapidity with which it can be applied. It looks well at first but it does not wear well. Every scratch shows up on it very clearly, and cannot be rubbed out except by refinishing the entire stock. After a time such a stock loses all semblance of polish and looks miserably. But a stock which has been finished with varnish can always have the varnish removed and be refinished with oil.

The oil finish seen on stocks varies from the plain oil treated military stock to the exquisitely finished dull London polish which brings out all the figure of the wood, and at the same time persists for years. Besides the beauty of a fine oil finish, its durability recommends it. Such a finish can always be restored by a little judicious rubbing with the proper oil.

Stocks on military rifles have a very simple oil treatment to prevent swelling and warping of the wood, and to resist moisture. The stock, before assembly to the rifle, is dipped several times in raw linseed oil, usually warmed, for any length of time from a few minutes to a day. After this it is set up on end and permitted to drain back into the dipping tank, and then set aside for a few days to dry thoroughly. No attempt is made at polishing, although the soldier often goes a long way in polishing the stock of the rifle issued to him.

The very best finish is the rubbed dull linseed oil finish. It takes time to apply this, but it certainly pays in appearance and durability. To apply this polish the amateur gunsmith should proceed as follows:

First the stock should be sandpapered perfectly smooth with several grades of sand paper, ending with the very finest or with crocus cloth. Between each grade of paper the stock should be thoroughly wet with water and then quickly dried over a stove. This process is thoroughly described at the end of Chapter I. If the stock to be refinished is an old one the original polish should be removed first, and it should then be sandpapered, wet, dried, and sandpapered again as described above. To remove the varnish or other finish from an old stock, procure some varnish remover from a paint store and proceed as directed on the container. With most removers you simply coat the surface of the old stock with the remover, let it stand for half an hour, and then rub off, repeating several times until every vestige of the varnish is removed.

To polish, all the metal parts should be removed from the stock except perhaps the butt-plate. See that the stock has been polished and the grain rubbed down as described above, and that it is perfectly clean.

Procure some raw linseed oil and turpentine and mix it in the proportion of two parts of oil to one of turpentine. Paint the stock thoroughly with this, or swab it on with a rag. Then stand the stock up to dry. These coats must be continued until the stock will not absorb any more of the mixture. It is best to paint the stock heavily with the mixture night and morning. At first

a coat will completely dry into the pores of the wood in the intervening twelve hours. You put the oil on thick, and when you examine it next the surface of the wood will be almost dry. When, after the expiration of twelve hours the stock appears to be just as wet with the mixed oil and turpentine as when you last painted it on you have applied enough coats. The number of coats which have to be applied differ from three or four in the case of close grained Circassian walnut, to 15 or 20 in the case of very porous American walnut. Right here the professional gunsmith usually shortens this operation by using a paste walnut filler instead of all this tedious oil coating, but he does not get as deep a finish or as permanent a one, and he has not preserved the wood so thoroughly, nor has he so well insured it against absorption of moisture and swelling and warping. Once in a while one will get hold of a particularly porous piece of wood that seems to absorb coats of oil without limit. After fifteen or twenty coats have been applied there is no objection to hastening the filling of the pores by using a paste walnut filler which can be obtained from any large paint store.

As has been said, when enough coats of the oil and turpentine have been applied to fill the pores thoroughly, a lapse of twelve hours will still find the stock wet with the mixture. The stock should then be permitted to stand from six to twelve hours (more if necessary) until the surface oil feels just a trifle sticky. Don't let it get very sticky or gummy or you will have a rather difficult mess to handle. In this shape rub the stock practically dry with the palm of the hand or a piece of burlap or old carpet. If you use the latter instead of the hand, use a small piece, and get the stock dry by rubbing the sticky oil into the pores of the wood, and by

friction, and not by absorbing the surface oil with the rag. The rubbing of this slightly sticky oil into the pores may take an hour or more. This fills the pores of the wood as thoroughly and as deeply as possible, and we are now ready for the polishing proper.

For polishing boiled linseed oil should be used. Get the genuine boiled oil if you possibly can. It is hard to obtain. In these days the so called boiled linseed oil is nothing but raw linseed with a dryer added. The secret of the very best finish consists of filling the surface pores of the walnut with a vegetable oil that has been partly oxidized. This gives a finish that resists wear, is hard, and that brings out all the latent grain of the wood. Linseed oil is best oxidized by boiling. But boiling oil is a tedious process, and to do it safely and properly requires special equipment. Do your best to get your paint store to give you genuine boiled linseed oil. If you cannot possibly get it then you must use the commercial so called boiled oil with the dryer added. You will get pretty good results with it, but your stock will remain more or less sticky and oily for a long time after the final finish, and the resultant polish will not be quite so good. Nevertheless very good results can be obtained from ordinary commercial boiled oil.

In first applying the boiled oil you can usually put on a pretty thick coat, enough to make the stock look shiny and wet all over, say about a teaspoonful to the stock each time. After three or four coats, applied from six to twelve hours apart, the surface may seem a little sticky after the oil has dried on for a few hours. Rub this in well with the palm of the hand. Now you should put the oil on much more sparingly, placing only a few drops in the palm of the hand, and rubbing it into the surface most thoroughly until you get the stock practi-

cally dry each time. These final rubbing coats may be applied as often as desired, and each time the resulting polish will be just a little bit better. I have heard of stocks being polished in this way every day for six months, but usually from five to ten rubbings will suffice for a very satisfactory polish.

During this stage of polishing some part of the stock may get a little sticky, and it may seem almost impossible to rub this stickiness off. A very little gasoline rubbed on this portion will remove this sticky oil. Or, instead of plain gasoline, it is better to use genuine beeswax dissolved in gasoline. You can usually get genuine beeswax at a large drug store, but do not be satisfied with the ordinary mineral wax substitute for beeswax.

This rubbing with the boiled linseed oil is all there is to the polish. Remember, towards the end, very little oil, only a drop or two, and a most thorough rubbing until the surface of the stock is dry. After you have applied as many coats as you desire, set the stock aside for a day or so to thoroughly dry. If you have been using genuine boiled oil the stock should now have a dry, hard surface and a beautiful dull polish. If, however, you have had to use the oil with the dryer added, the stock will not be so dry and hard, and it should be carefully guarded against dirt and knocks for several weeks, and rubbed hard with the hand as often as possible until the surface has become thoroughly dry and hard.

Thereafter a few drops of boiled oil rubbed in every month or so will preserve the polish indefinitely. If you get caught out in the rain, or if you get the stock wet with perspiration in a tropical climate, use the boiled oil as soon as possible to restore the finish.

Scratches that are not deep may be rubbed out by the same method, but anyhow scratches do not show in an objectionable manner on such a finish.

Now for a few little odd details. In first applying the raw linseed oil, put it on the inside surface of the stock as well as on the outer surface, getting it in the barrel groove, cuts for the action, etc. But just as soon as this raw oil begins to show signs of gumming, wipe these interior surfaces off, and do not oil them thereafter.

The checking may be oiled with both the raw and the boiled oil, and it should then be rubbed into the checking with an old tooth brush, and then the checking rubbed practically dry with another dry brush. Do not let a thick coating of oil dry in the checking under any circumstances. Take no chances on the oil gumming in the checks. Usually three or four coats of each kind of oil on the checking will suffice.

To finish a stock in this manner will take anywhere from a week to several months, depending on the character of the wood, and the number of final polishings given. Usually but several minutes, twice a day, are required, although for the final polishings, where only a couple of drops of oil are thoroughly rubbed in with the palm of the hand, it usually takes about twenty minutes for each polish.

CHAPTER IV.

Rifle Chambering and Barrel Work.

THE amateur gunsmith may have a new barrel which he wishes to chamber for a special cartridge and fit to a receiver. He may have individual ideas as to the outside taper and shape of barrels, and wish to turn this one down to conform.* Or he may have a military rifle which he is remodelling, and when he removes the stock and the military sights he sees that the barrel has to be turned down slightly and polished before it can be finished and blued to give a pleasing appearance.† We will take a case where one has a barrel in the rough, bored and rifled, but not chambered or threaded for the receiver. Such barrels usually measure 1⅛ to 1¼ inches from breech to muzzle. The various operations necessary to completely finish such a barrel will include practically everything that the amateur can hope to do on a barrel. The boring and rifling of a barrel requires special and very expensive machinery, or else the most expert knowledge of lathe work in order to set a lathe up for the job. Engine lathes with beds long enough for such a job are seldom found in the ordinary machine shop. The skill of a regular toolmaker is necessary in making many of the tools which cannot be bought anywhere. Boring and rifling barrels is therefore an art in itself and is here considered beyond the capabilities of almost all amateurs.

*For instructions as to how to dismount and assemble the Springfield military rifle, remove sight bands, etc., see "Handbook of the U. S. Rifle, Model of 1903," which can be procured by members of the National Rifle Association from The Director of Civilian Marksmanship, War Department, Washington, D. C.

†There are several commercial sources that can furnish barrels of all calibres and twists of rifling, and either completely finished or finished only as to boring and rifling with the exterior the shape of the original blank.

The work we are now going to describe requires a certain mechanical knowledge and ability. The amateur should be fairly familiar with the operation of a lathe and the use of metal tools. The more enterprising amateur gunsmith may have a little machine shop of his own, and be fairly familiar with these matters. Any mechanic or toolmaker will have no trouble.

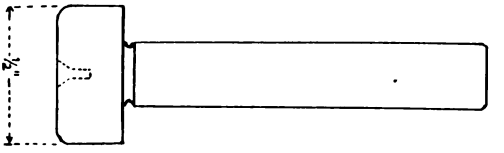


FIGURE 9.

Many motor mechanics have the necessary skill to develop into good men at this sort of work. For the correct set up of tools and work the amateur is referred to any good work on machine-shop tools and practice, and particularly to "Text-Book of the Principles of Machine Work" and "Text-Book of Advanced Machine Work," by Professor Robert Henry Smith of the Massachusetts Institute of Technology.‡

A first-class engine lathe is necessary. It should have a swing of 14 inches and a bed of 6 feet. Such a lathe will turn about 35 inches between centers. In the following description certain mechanical terms will be used and certain set-ups described by name. The uninitiated reader who may not understand can find full explanation by referring to the above-mentioned works.

CHAMBERING RIFLES.

It is best to start the operation of chambering before the barrel is threaded for the receiver, and then complete it after the barrel has been screwed into the receiver.

‡Published by Industrial Education Book Co., Box 153, Back Bay, Boston, Mass. The first book is out of print, but a revised edition is being brought out. The last mentioned book is considered the best work on the engine lathe. Both are text books used at the Massachusetts Institute of Technology.

The chamber end of the barrel must be bored out first almost to the dimensions of the body of the cartridge case before the chambering reamers can be started. This preliminary boring must be very accurately done, and must be in absolute line with the axis of the bore or the rifle will prove very inaccurate when fired. If the chamber be bored out of line the chambering reamers will tend to follow it despite their pilots, and the chamber will be way off. In order to get this boring accurate it must be done on the lathe.

First you must make a plug for the muzzle to hold it in the lathe. This plug is shown in Fig. 9. It must be made of hardened steel, and must be ground on centers.

If made of soft steel it is liable to cause wear, and to freeze in the bore. The long shank which goes into the bore must be a push fit on the top of the lands of the rifling. The center hole must be located and drilled with a small drill and then be countersunk with a 60 degree countersink as in all lathe work. Put the muzzle plug in the end of the bore that you select for the muzzle, and fit this end to the live center of the lathe, attaching a lathe dog to the barrel. Center on the chamber end with the dead center, and bring the footstock forward until the barrel tightens without any lost motion between centers. Tighten up on face plate and dog with raw-hide belt lacing. Then turn a length on the barrel about 2 inches from the breech end to a true diameter for the steady rest to run in. Set up the steady rest at this point, being very careful to get it to run accurately on the center as determined by the live and dead centers, and then bring back the foot-stock. Bring the carriage up to the chamber or breech end of the barrel, and using the compound slide with boring tool,

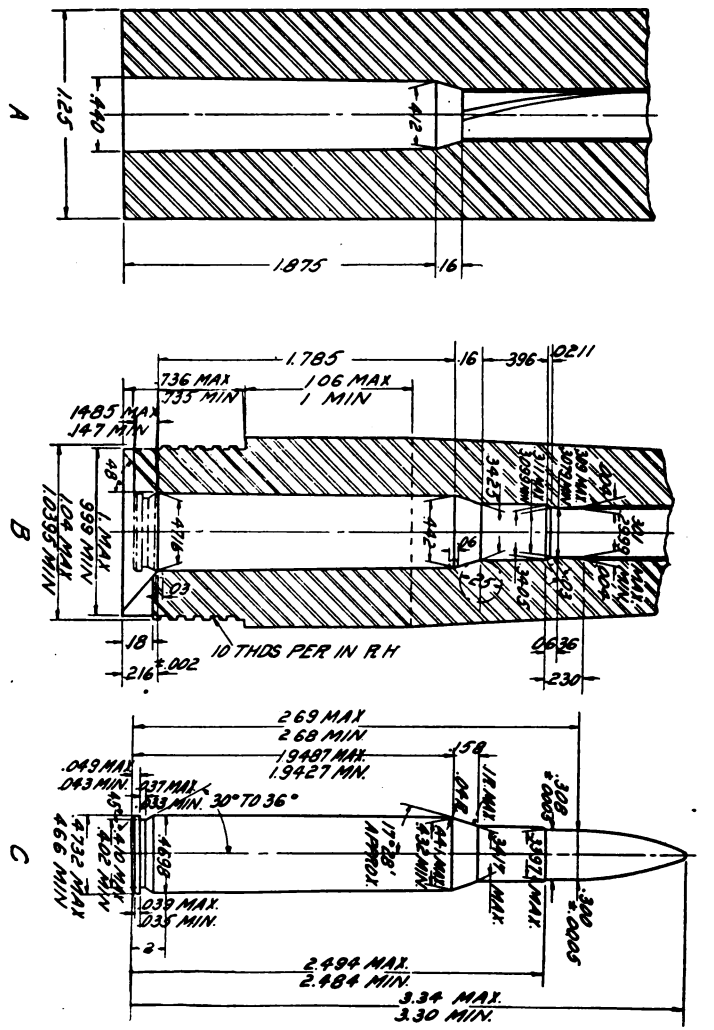


FIGURE 10.

Boring and reaming of chamber .30 caliber, Model 1906.

set up for inside boring. Start boring inside the bore at the chamber end, boring out the portion of the chamber into which the body of the case fits, but boring in only to a point about 1/8-inch short of where the shoulder of the finished chamber will be, and about .03-inch smaller in diameter than the finished chamber at all points. (See Fig. 10-A.) Set the tool to bore at the same angle as the angle on the cartridge case. (This is the angle which makes the case larger in diameter at the head than down at the shoulder; in other words, the taper to the body of the case which permits of easy extraction.) This operation requires a great deal of care, and the bored-out portion must be absolutely true with the axis of the bore. It requires skill to do it correctly. If the amateur has not the necessary skill he is very liable to spoil the chamber at the start, and it is better to call in a first-class toolmaker or master machinist the first time or two and watch him do the job. Skill will come with a little practice and a knowledge of just how to set the work and what to do.

We are now ready to proceed with the chambering reamers. There are usually three reamers: the roughing reamer, the finishing reamer, and the burnishing reamer; used in the order named. The making and grinding of reamers requires high mechanical skill, and a long apprenticeship to learn it. If the amateur has not this skill he must depend upon a good toolmaker to make them. Any first class toolmaker, accustomed to make reamers, can make them correctly if he be shown this chapter, the sketches that accompany it, and be given a sample cartridge for which the chamber is to be cut. The same relative tolerances and clearances between cartridge and chamber should be maintained as is shown in Fig. 10.

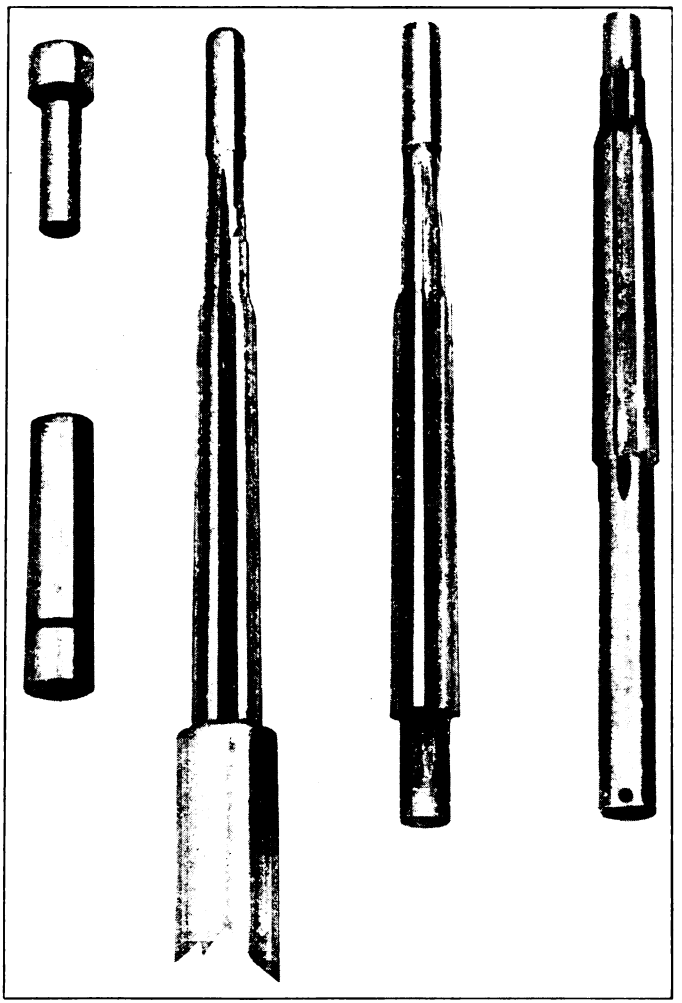


FIGURE 11
Muzzle and breech plugs and chambering reamer for the .30 calibre 1906 rifle (reduced to 5/7 actual size).

Fig. 11 shows a set of chambering reamers for the .30 calibre, Model 1906 cartridge. Notice that at the point of the reamers there is a pilot which runs in the bore of the barrel ahead of this chamber. This pilot should be almost a push fit on the lands; that is, it should require just a little pressure to push it into the bore, where it of course, runs on top of the lands. It will keep the reamer cutting in exact line with the axis of the bore provided the body of the chamber has been bored out in true line with the axis of the bore on the lathe as described above.

Figure 10 shows (A) the body of the chamber bored out ready for the reamers. B is the shape and dimensions of a standard chamber for the .30 calibre Model 1906 cartridge. The tolerances are those prescribed for quantity production, but it is best to cut to the minimum figures. C is the outside dimension of a .30 calibre Model cartridge for which chamber B is cut. In making chambers for other cartridges of similar type it would be well to preserve the same relationship between the size and shape of the chamber and the size and shape of the cartridge.

Now take your barrel out of the lathe and hold it in a heavy vise. Hold the reamers in a tap wrench. Use the roughing reamer first, running it into the bored out chamber, turning it with the tap wrench, and cutting with it down to the stop which prevents it going too deep. Then use the finishing reamer, but do not run this reamer completely home by about .02 inch until the receiver is fitted, so you can then run it in finally just enough to get the correct headspace.

Next the barrel must be put back in the lathe and threaded at the breech end for the receiver, and if nec-

essary countersunk for the lead or taper which leads the cartridge into the chamber. The threading of the barrel for the receiver is a mechanical operation familiar to any good machinist, and it will not be necessary to describe it in detail. The thread should fit the receiver without any lost motion, and the barrel should screw up by hand to within about ¼-inch on its circumference of its position when fully home. To tighten the barrel into the receiver, place the barrel in a heavy vise. If the barrel is still in the rough outside it may be grasped by the naked jaws of the vise. But if the outside of the barrel has been turned to a finish or blued, a cast iron clamp, bored out to the proper diameter and taper for the breech of the barrel, must be made to go in the vise and grip the barrel in such a way as not to mar the finish. Such a clamp is shown in Fig. 12. The flanges on top rest on top of the jaws of the vise. The length of the clamp is the same or a trifle longer than the width of the jaws. The distance from side to side of the clamp outside is a little greater at the top (just under the flange) than at the bottom, the angle being about 2 or 3 degrees, so that as the vice is closed the clamp will tighten on the barrel and hold it securely. The barrel being in the clamp and tight in the vise, put a heavy monkey wrench (18″ to 21″) on the receiver, fitting it to the flats of the receiver, and padding the jaws with two or three thicknesses of paper to prevent scratching the receiver. Tighten the monkey wrench on the receiver with pliers, and then screw the receiver fully up on the barrel until the barrel is completely home. On the lower left-hand side of the barrel and receiver where they will be covered by the wood when the rifle is stocked, cut two index lines in culmination

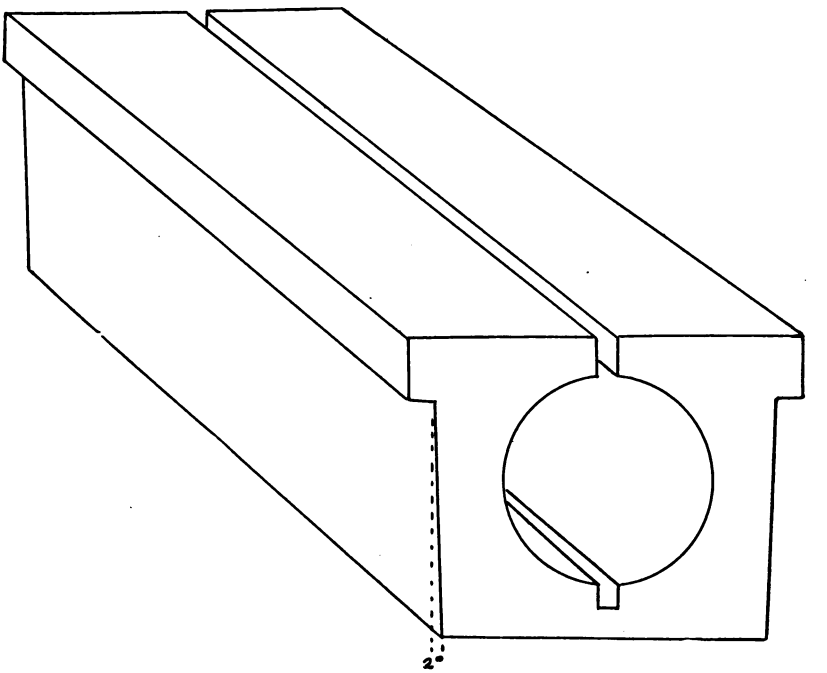


FIGURE 12

Clamp for holding rifle barrel breech in vise.

with each other, so that when the receiver and barrel are again screwed up you will know that they are correctly screwed together when these index lines come into line.

Now you are ready to put the finishing touches on the chamber so as to get the correct headspace—that is, the correct distance between the head of the cartridge in the chamber and the face of the bolt or breech block. This headspace should be such that when a cartridge of the maximum dimensions is fully pushed home in the chamber the bolt or breech block will close without effort, but will have almost a friction contact with the head of the cartridge case. Rifle factories have headspace gauges to determine this. Lacking these gauges the amateur will have to use a cartridge of maximum dimensions. Go over about 50 new cartridges with a micrometer and select the one which seems to be the largest, particularly the longest, for a headspace gauge. Put this in the chamber and close the bolt. The bolt probably will not close completely because your chamber was purposely left about .02-inch too short when you laid aside the finishing reamer. Now run in the finishing reamer again just a little, then try the big cartridge again. Continue trying the cartridge and running in the finishing reamer a little until finally the bolt will close on the big cartridge with just a suspicion of a little effort at the very end of the closing. Now use the burnishing reamer just enough to give a good polish to the chamber, but no more. Again try your big cartridge in the chamber. The bolt should now close on it without effort, but a very thin piece of paper placed between the head of the cartridge and the face of the

bolt should cause a very slight effort in completing the closing of the bolt. This matter of headspace is important. If the headspace be too big the accuracy will be poor, and on firing the cartridge the case may separate, splitting in two pieces between the shoulder and head. Also in rifles for rimless cartridges misfires may occur because such rifles depend upon the correct distance between the shoulder of the chamber and the face of the bolt to hold the primer up against the blow of the firing pin or striker. If the headspace is too small the breech bolt cannot be completely closed on a cartridge, particularly on cartridges that are a little large; or it can only be closed with an effort that disconcerts the marksman in rapid fire.

In adjusting the headspace you must look out that the tight fitting of the bullet of the big cartridge in the lead (taper of the lands at front end of chamber) is not holding the cartridge back and making you believe the headspace is too small. You may be deceived in this way, and thus cut your chamber too deep and spoil it. Better insert the big cartridge in a loading tool and seat the bullet in just a little so that this cannot occur, and afterwards test with other cartridges to see that the lead is just right. To determine that the lead is right, give the bullet of a factory cartridge a very light coat of paraffine, and after the wax is cool insert the cartridge in the chamber and close the bolt. On extracting this cartridge the imprint of the lands should show up clearly on the paraffine, and indicate that the bullet is practically touching the lands when the bolt is closed. If the finishing reamer is correct it should cut the lead absolutely right every time, but it is better to have a reamer that cuts too short a lead than too long a one, because a lead

that is too long can only be corrected by entire rechambering, whereas if the lead is too short it may be reamed out with a special reamer a very little at a time until it is just right.

Turning and Polishing.

Our barrel is now finished inside, but it still measures about 1⅛ inches from breech to muzzle with the exception of the threaded portion at the breech. We now have to turn it down to proper dimensions, and polish it so that it will appear well when blued. The smoother the polish the better will it look after bluing. Modern high pressure barrels are usually shaped with a straight cylindrical portion at the breech. This portion is about an inch long, and from an inch to an inch and an eighth in diameter. Then the barrel decreases with a straight taper about 2 inches long to a diameter of about .90-inch, and for the remainder of the barrel there is a straight taper to the muzzle where it should measure about .68-inch; this for barrels from .25 to .32 caliber.

We are going to turn the barrel down to these dimensions, or to any you wish, on the lathe, so place the muzzle plug back in the muzzle of the bore, and make a breech plug similar to the muzzle plug (see Fig. 9) except that the shank should be ground to a taper to fit tight into the body of the chamber, extending down to within about .25-inch of the shoulder. Be sure that it fits to the correct body angle of the chamber, and that it is hardened so that it will not freeze in the chamber. Insert this plug in the chamber, and place the barrel in the lathe with the chamber end to the face plate and the live center in the breech plug. Place the dog on the breech of the barrel and secure it to the face plate with raw-

hide belt lacing as before. Bring the tail stock up until the dead center enters the center hole in the muzzle plug. Run the carriage to the right of the bed, and turn a spot for the steady rest to run in, about ten inches from the muzzle. Set up the steady rest at this spot. Then set up the taper attachment to the taper you wish to turn on the barrel. (Do not attempt to set over the footstock to turn any taper on the barrel. There will be too much strain, and you will never know when you have taken off enough surplus stock, and the barrel may warp crooked on you without your knowing it.) Now start turning off the taper on the barrel. Where an exceptional amount of metal is to be turned off it is best to use heavy feeds and small cuts. Watch the barrel for heating and don't let the tool become dull. If the barrel becomes much heated it will probably warp crooked.

Turn the barrel in the rough from muzzle to steady rest, then turn a spot for the steady rest about 10 inches nearer the breech, move the steady rest to this point, and again turn the barrel in the rough up to the steady rest. Then set the steady rest up to the right of the carriage, and again turn to the breech end, altering the tapers to conform to your desired shape as you near the breech.

Each time, before removing the steady rest, draw back the dead center a little and revolve the lathe by hand to see if the barrel is running out of true at the muzzle. If it is, to straighten it take a bar with a block of wood on the bed of the lathe or the carriage. Turn lathe by hand until the center of the muzzle plug is at its greatest distance below the dead center (greatest curve straight down), and with the bar levered on the block of wood, draw the barrel up vertically until, when the pressure

is released, the barrel will come back with its muzzle plug at true center as shown by the dead center. Turn the barrel by hand and it will usually be found to be out a little in another direction. Straighten this in the same way, and repeat the operation until when the barrel is revolved by hand it runs absolutely true with the dead center. Then move steady rest for turning on the next length of barrel, being sure that it is so set up that it will run true with both bore plugs, the three jaws of the steady rest pressing equally on the spot turned for them.

This rough turning is to be carried to within about $\frac{1}{32}$ inch of the desired finish diameter. The barrel now has the correct shape and taper, but the surface is rough turned and slightly over size. Next in order is the finish turning. The steady rest is not absolutely necessary for this if care be taken in turning, still it would be wise to set it up in the middle of the barrel and turn half the barrel at a time, and verify the straightness of the bore when you move the steady rest. In this finish turning the tool should be set as high above the center of the work as possible to do away with chattering. A diamond point tool should be used, and it must be kept very sharp. Use a fine feed and light cut.

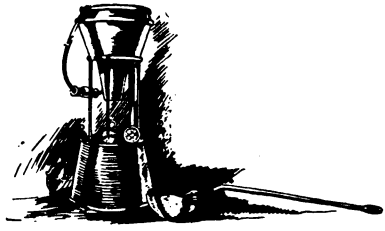
After finish turning, keep the barrel in the lathe on centers and use a mill file to remove all tool marks. A good practice is to use chalk on the file so that it will not fill up with chips and score the barrel. After removing all the tool marks go over the barrel again, using medium emery cloth on the file. Follow this with fine emery cloth with oil. Take the barrel out of the lathe and draw polish lengthwise of the barrel with

fine emery cloth until all scratches have been removed. Then place back in the lathe, and polish with fine French emery paper until the barrel shows up with almost a mirror surface. Finally finish the polish with crocus cloth. The barrel is then ready to fit the bands and sight bases as desired, and to blue.

Sometimes the amateur may have a military rifle which he is remodelling into a sporting arm. Upon removing the hand guard, fixed sight bases, and barrel bands he may find that the barrel is rather rough, not blued its entire length, and it may have some sharp shoulders or ungainly shapes. He wishes to polish it up and reblue it. Not all the operations enumerated above are necessary in such a case. Muzzle and breech plugs should be made as above, and the barrel removed from the receiver and placed on centers in the lathe. Then finish turn off the shoulders and ungainly marks, afterwards using the mill file to remove all tool marks, and finally polishing as described above.

Sometimes a sportsman may have a rifle, the bore of which has become rusted, or is otherwise undesirable, and he gets the idea that he would like to have the barrel rebored to take a larger cartridge. This work was done quite frequently with target barrels for single shot rifles many years ago, but it is hardly ever advisable today. Also it is very expensive work, much more so than the making of an entirely new barrel. Consider what has to be done to rebore and re-rifle a barrel. It has to be taken out of the receiver, all the sights removed, and then a boring machine has to be taken out of regular production and set up specially for this machine. While this boring machine was in regular production it was turning out a number of barrels every day, and it was operated by a machine operator at a salary of about

$5.00 per day. But to set it up for this special job requires that one of the most expensive machinists in the room, or perhaps the foreman, do the work, and he may get twenty dollars a day. It takes that machine out of production for several hours, during which time it would have bored perhaps six regular production barrels. Exactly the same procedure has to be done at the reaming machine, and also at the rifling machine, only at the last machine it may take almost half a day to get the required setup. No factory wishes the disorganization that comes from such work. It is always cheaper to buy a new barrel of the caliber desired which can be made in the regular course along with other barrels of similar caliber, a machine being set up but once for perhaps a hundred or more barrels.



CHAPTER V.

The Bluing or Browning of Barrels, Receivers and Parts.

THE problem of giving a satisfactory, pleasing, and rust-resisting finish to the metal parts of small arms has engaged the attention of manufacturers for the past century. A number of different methods can be found in print, but after investigation it was found that invariably these were very inferior processes, probably discarded long ago by gunsmiths who had discovered much better formulas. Many firms and gunsmiths have methods which are regarded as trade secrets. Other firms use patented methods under license. It was most difficult to obtain reliable information on this subject. As a consequence it has been necessary to thoroughly investigate the whole subject, and it was found that matters were so complicated that expensive and extensive experimenting had to be done to be sure that the processes here recommended could be practically applied by the amateur, and if correctly applied would be successful.

The different methods of bluing can be conveniently classified as (1) Solution Methods, and (2) Heating Methods. The latter are limited in their application to those parts which will not be injured by heating, and cannot be applied to certain parts of the breech mechanism, receiver, or barrel where the characteristics of the steel would be changed by the heating.

The modern methods of bluing used by the large arms manufacturers result in a most uniform, pleasing, and wearing finish. These methods are complicated, require elaborate installation of equipment, and are not

applicable to the amateur. Neither can the amateur expect to equal the results obtained by these most modern methods with the small equipment and rather primitive methods with which he must work. Nevertheless he can do very creditable work indeed if he uses both care and patience. Perhaps he will not succeed the first time, but practice will bring success with the methods to be described later.

Formerly all finishing of barrels, receivers, actions, etc., was done by the so-called "Browning" method. The parts were polished, rendered absolutely free from oil and grease, and then covered with an acid solution which caused a thin coating of rust to form in a few hours. This coating was carded smooth and there remained a slight blue or brown color on the steel. The acid solution was applied again and again, with cardings about 12 hours after each application. After each carding it was found that more and more of the smooth blue or brown color remained, until after five to thirty of the applications a pleasing and uniform dark blue or brown coating had been given to the entire surface. Finally the progress of the rusting was killed with boiling water, and the part polished with oil. This in general is the method which still has to be used by the amateur. In order, however, that it may be understood why he cannot get the quick and pleasing results of the commercial companies, it has been thought best to first describe briefly the methods generally followed by those companies. Generally speaking, these methods are quicker than amateur methods, and result in much thicker, and slightly more uniform coatings.

The Government Arsenals use a process known as the Parker Process under license from the patentees. This gives a dull gray black finish, which, while not as

attractive as some finishes, is much more resistant to rust than any of the others, and also reflects light less than the others, both important military points. Parkerizing is a development of the Coslett process patented in 1907, and consists in the formation of insoluble phosphates on the surface of the pieces treated. The process is licensed to the users, who are furnished with instructions for using the solutions which are sold to them by the patentee. The process consists of first sand blasting the pieces to be finished to give them a slightly rough surface which is necessary for the blackest and even appearance. The pieces are then immersed in a weak solution of iron phosphates at 210 degrees F., until the evolution of gas resulting from the surface reaction ceases, a period of 40 minutes to two hours, depending upon the condition of the solutions and the size of the pieces. It is important to maintain the processing tank at the proper strength with respect to the acidity and degree of oxidation. This is done by simple chemical tests, and the experienced operator can detect from the appearance of the work.

Smith and Wesson revolvers have been celebrated for the excellence of their bluing for many years. Certainly no other makers excell, and but few equal the finish on these weapons. The blue is heavy, most uniform, and has a beautiful color and shine. This bluing is done in a Carbonia gas heating machine. The work to be blued is placed in rotating cylindrical drums in the machine, together with the correct proportion of oily charred bone, and the whole heated to the proper temperature, and left in the machine for a certain time. A rack containing 100 revolver frames can be given a deep blue black finish in about seven hours' time. The pieces are quenched in oil after treating. The quantity of bone and

oil in the charge has to be carefully regulated, as well as the temperature, which varies from about 600 to 700 degrees F, the higher temperatures giving a deep black finish, and the lower tending to more of a blue color. It is very important to have the work properly polished and cleaned before treating, and the temperature has to be carefully controlled to get uniform color. The success is also due largely to the polish given the parts before treatment. This last applies to all bluing operations except the Parkerizing, the smooth, glass-like surface depending largely on the smoothness of the polish.

With these short explanations we will now proceed to the processes which the amateur will find possible and practicable with extemporized equipment.

Let us now consider the bluing of barrels and receivers.

First the work must be polished as smoothly as possible. Try to attain almost a mirror surface. (See preceding chapter.) Next, and most important, the surface to be blued must be rendered absolutely clean and free from the slightest trace of oil or grease. If there is the slightest trace of these present, failure will result. Say you have a barrel to blue. Make hard maple plugs for the muzzle and chamber. These should be turned up about 6 inches long, and about .01-inch larger than the bore and chamber. Coat the bore and chamber with gun grease, and drive the plugs in so as to absolutely seal the bore at each end, and leave about four inches of the plug protruding to handle the barrel with. It must be remembered that the hands always contain oil, and from now on the hands must never touch the steel. Even the slightest touch will leave a plain and ugly mark, and may spoil the whole surface. Do not use woolen rags as they also contain oil. Use only *perfectly*

clean cotton rags and cotton gloves in handling the steel wool and the plugs, and remember to touch only the plugs.

Now, you must have a tin pan about 36 inches long, 4 inches wide, and 4 inches deep. It will facilitate matters if you can rig this up on a stand with three or four gas jets under it, but this is not absolutely necessary. Fill the pan with hot water in which has been dissolved about 8 ounces of lye or sal-soda. Put the barrel in this and agitate the water for about five minutes. Take the barrel out, handling it by the plugs at each end only. Wash it off with hot water. Empty the tank and fill it again with hot water in which lime has been dissolved until the solution is about the consistency of medium thin milk. If you have gas jets under the pan let the barrel boil for a few minutes; otherwise let it stay in for fifteen minutes. Lift out by the wooden plugs only, and let the lime water drain off for a few minutes, being careful that nothing touches the steel of the barrel when you stand it up or lay it on its side. Use a rack which will support the barrel clear by the plugs.

In the meantime you should have had the following bluing solution made up and put in a colored glass bottle and labeled "POISON."

Tincture of Ferric Chloride (U. S. P.)	1 ounce
Alcohol (95% by vol.)	1 ounce
Bichloride of mercury	¼ ounce
Nitric acid (Sp. Gr. 1.40)	¼ ounce
Copper sulphate	⅛ ounce
Water-distilled	1 quart

It is perhaps best to have this solution bottled a week in advance. It should be kept in a colored bottle in a dark place, and not subjected to strong sunlight.

Make a swab of a stick that you have boiled in soda water to be sure that it does not contain oil, and a piece of perfectly clean cotton rag free from lint. Dip this

in the solution, and, handling the barrel by the plugs only, give the barrel an even coat all over, applying the solution by long strokes lengthwise of the bore. When it is thoroughly wet all over (which takes only a minute or so) set the barrel upright in a damp, warm place for 12 hours. The place where you put the barrel aside is most important. It should be both damp and warm. You cannot expect to get good results in a cold cellar, nor in a steam heated house where the air is always very dry. The temperature and humidity must be such as will promote rust. Leave the barrel in this place without handling for 12 hours. Then take it out, handling by the plugs only. It will be found covered with a slight coat of rust. Now take a fistful of steel wool. Hold it in the center of a cotton rag so that neither the rag nor the hand can come in contact with the barrel. With even, light strokes, applied lengthwise of the barrel, carefully card off the red rust coating, evenly and completely. Under this red rust you will see a slight blue coat forming. After carding off the rust, again apply the bluing solution as before described, and put the barrel back in the warm, damp place. Continue carding and applying the solution every 12 hours, that is, morning and night. Each time, when you card off the red rust you will notice the remaining color of the steel getting more and more of a blue-black color. The application of these coats and the carding must be continued every 12 hours until you get the heavy, even, deep blue-black color desired. The number of coats necessary will depend largely on how rust producing is the temperature and humidity of the place where you stand the barrel. Each time you stand

the barrel up in this place reverse it; that is, one time breech up, next time muzzle up. Generally it takes at least 15 applications of the solution, but it may take 30 or even 40 applications. Be extremely careful not to let your fingers touch the barrel; use only clean steel wool free from oil, and clean cotton. Better wear clean cotton gloves.

When, after carding, you think that the blue color is about right, or is as near right as it is likely to get, pour boiling water over the whole surface of the barrel to kill the rust and prevent further corrosive action. Use plenty of boiling water, and continue to pour it until the barrel gets very hot. Then go over it evenly and softly with cotton rags just enough to get the surface bone dry. Now, while the metal is still hot, and the surface dry, apply liberal quantities of linseed oil with woolen rags, covering the barrel evenly with long, gentle strokes, and gentle pressure. It is quite easy to remove the bluing in spots by hard rubbing at this stage. Watch the barrel for a few days to see if further rusting takes place. If you see any indication of it wipe off the oil and again pour boiling water over the surface, and yet again apply the linseed oil as before. Future applications of the linseed oil will tend to darken the color and prevent rust. Do not be in too much of a hurry to assemble a newly blued barrel to stock and receiver. Better give it a week to get hard.

The success of this operation is largely dependent upon attention to the little details. Almost everyone of these details is absolutely vital to success.

There are a number of bluing solutions of the character of the one given above. In fact, we have tried about 15 of them, and believe that we have selected the very

best. All of them have one fault, but it is believed that the solution given possesses this fault less than the others. This is that on some steels they will give a brown color instead of blue. This is the oldfashioned brown such as was often seen on muskets and guns of 75 years ago. This brown color usually comes on the soft black powder steels, and seldom on modern smokeless or nickel steel. In fact, we have never gotten it on any steel with this solution, but we know that it will turn brown on some steels of certain composition. It works well on the regular smokeless and nickel steel used by all our factories for high-power rifles, giving a shiny, even, gray-blue color that is very pleasing. It works slower than many solutions, each coat of rust being thinner, but we have found it surer and more reliable than any of the other solutions tried.

Receivers, trigger guards, and floor plates can be blued in much the same manner and by the same solution as barrels. First all screw holes must be plugged up by tightly screwing wood plugs into them. Let the largest of these plugs protrude to handle the work by. With a receiver it is best to screw a large wood plug into the barrel threads as you thus avoid the difficulty of carding and scrubbing a lot of rust out of a place that is hard to reach with the steel wool. Usually it is most convenient to screw the barrel and receiver together and blue them at the same time. Receivers should be most thoroughly polished. If the work is one that has many cuts in it, or places that cannot well be reached to card off the rust caused by the solution, or in the case of engraved parts, it is better and cheaper in the long run to send the part to the repair shop of one of our large arms factories to have the work done by skilled specialists. The bluing of some receivers, particularly

engraved receivers, is a pretty complicated matter, requiring lots of experience and elaborate equipment. I have known one of our largest and most experienced arms factories to make six failures to blue an engraved receiver before they finally made a success of it. It is easy to blue breech blocks and bolts by this process because the interior of the bolt or block can almost always be plugged up, and all of the exterior is then nearly as accessible for carding and the application of the solution as in the case of a barrel. Bolts and breech blocks should never be blued by a heat process as it might seriously change the characteristics of the steel, making it so soft that it would not stand the strain, and would upset and be forced back and deformed.

There is another method of bluing barrels and receivers with which I have had but limited experience. The results, however, were most excellent, and it is so simple, and can be done in such a short time, that I recommend its being tried. I would particularly like evidence as to its successful application.

Plug both ends of the bore and remove all grease as before described. Support the barrel in a horizontal position by resting its plugs on blocks at each end so that it can be rotated and every part readily accessible. Take a large cup or china bowl half full of a solution previously mixed in the proportion of 1 dram of crystallized copper sulphate (blue vitriol) to 12 ounces of distilled water. Apply this solution with a mop of clean cotton rag tied to the end of a stick, or, preferably, a clean soft varnish brush of about 1-inch size. Slop the solution on continuously, allowing it at the same time to drain back into the bowl. When the work assumes a

pinkish color take another bowl about one-third full of a concentrated or saturated solution of ammonium disulphide,* and in the same way apply it quickly but generously with as little contact of the brush as possible. Then take a third cup containing warm distilled water, and flush the work thoroughly. Then dry by blotting with soft, clean cotton rags without rubbing.

When dry rub very gently with a soft cotton cloth and inspect. If there are bare spots, again apply the copper sulphate solution without previously removing the finish, and follow with ammonium disulphide as previously. When the finish is dry it can be rubbed reasonably without damage, but if injured can be restored with additional applications. After finishing to your satisfaction, flush it with warm water again, blot dry with rags, rub lightly with rag to get completely dry, and finally go over it with a few drops of linseed oil and a soft rag. If the flushing water is about as warm as the hand can comfortably stand it will have a slight warmer effect on the barrel, and the linseed oil will spread easier.

Do not apply the ammonium disulphide solution unless immediately preceded by the copper sulphate solution as the former has a tendency to redissolve the deposit of color; this is the reason for not brushing it on. The copper sulphate solution may advantageously be brushed during application. Use a separate brush for each solution. The ammonium disulphide solution should be freshly mixed, and should not be used more than once. Keep it in a tightly stoppered bottle with rubber cork when not actually in use. This solution

*Ammonium disulphide cannot as a rule be obtained in drug stores. Any good chemist can prepare it to order.

stains badly and it is advisable to wear rubber gloves; stains can be removed, however, with hydrochloric acid.

The entire process does not take more than an hour when all material and apparatus are at hand. It gives a fine deep blue black color which compares very favorably with professional work.

There is a bluing solution on the market, put up and sold by Hoffman Chemical Company, Cleveland, Ohio, that has been used with excellent success for some time by amateurs as well as by a large number of professional gunsmiths. It works excellently on rifles and receivers, and is easy to apply and quick, taking only about twenty minutes for the complete bluing of barrel and receiver. In fact, it is so quick that it is called the "20 Minute Gun Bluing Solution." It gives a deep blue black color which wears very well. It is supplied in three ounce and one quart bottles, the smaller bottle containing sufficient for the bluing of from ten to thirteen barrels.

To use this solution the ends of the bore must be plugged with wood as before described, or if you wish to blue the receiver at the same time that you do the barrel, put a plug in the muzzle, and another through the receiver into the breech, letting the last named plug extend out to the rear of the receiver to handle it by. Absolutely all grease must then be removed from the outside as before described. From now on the fingers must positively not touch the metal, and all handling must be done with the wood plugs.

Have a tin or iron tank long enough to take the work. If you wish to blue the barrels and receivers attached it had better be 38 inches long, 3 inches wide, and 4 inches deep. This tank must be set up on a stand and at least three gas jets, or kerosene or alcohol lamps

arranged under it at intervals so that the water in it can be kept boiling hard. In the tank put two small blocks of metal or glass, one at either end, for the plugs of the barrel to rest on, so as to keep the barrel off the bottom of the tank, and not touching anything. Fill the tank full of rain water or distilled water. The water must be soft. Bring the water to a boil, so that it is boiling furiously. Have the bluing solution in a wide mouth bottle, and tie this bottle in one end of the tank, resting in the water, so that it will get hot with the water. When the water is boiling put in your work, handling it by a pair of wire hooks at each end, so the wood plugs rest on the blocks, and let it stay in the water at least two minutes so that it gets very hot. Make a swab out of a piece of *clean* cotton on a stick, and let this rest in the solution, so that it also becomes hot. After the work has been boiling in the water for two minutes take it out with the hooks, transfer it to the work table alongside, where it should rest on two rests, supported by the wood plugs only, and very quickly wipe off all water with a *clean* cotton rag, being careful that nothing else, especially the hands, touches the metal. The metal will then be perfectly dry. At once take the swab from the bottle of the bluing solution, squeezing all the solution that you can out of the swab against the neck of the bottle, and then go over the work with the swab, using long, even strokes, and completely swabbing all the surface evenly. The solution will dry on the metal as it is placed on. As soon as all the surface has been swabbed with the solution, at once plunge it back into the boiling water again.

In these operations it is important to work as rapidly as possible. Get the work out of the water, wiped off, swabbed with the solution, and back into the

water again while all is still very hot. If possible complete the whole cycle of the operation in a minute.

Now leave it in the boiling water one or two minutes, and again take it out with the wire hooks, and at once wipe the barrel with a clean cotton rag, using light, even strokes and wiping off all loose rust that may have formed on the work. See that your fingers do not come in contact with the work, and that your cotton cloth is large and clean. After this wiping put the barrel back into the tank and let it stay one minute in the boiling water. Take it out, rub off the water, and again give it a coat of the solution, and put it back in the water again. Continue in this manner, taking it out, wiping off loose rust, putting it back, taking out, wiping off water, applying the solution and putting back in the boiling water again.

As soon as you put the solution on the work you will notice the blue color coming, then a rust will form. Each time as you wipe this loose rust off you will notice the steel getting blue in color, and this blue will deepen in color after each application. Each time the rust forms on the steel the boiling water kills it, you then take it out of the work, rub off the loose rust, put in the boiling water for a minute more, apply the solution again, put it in the water for a minute, and proceed in this way.

Repeat this operation until you get just the color you want. Usually it will take about eight coats. When this color has been obtained boil the work for three full minutes, then take it out, dry it slightly, and immediately wipe it off with a *woolen* cloth and boiled linseed oil, wiping it *gently* so as to get a good coat of oil all over it, and then let it stand until it is cool.

Remember that all your work after you start must be done as quickly as possible, keeping the water energe-

tically boiling, getting the work back in the boiling water as quickly as possible after applying the solution, keeping the solution itself hot, and getting the solution on quickly. Above all keep your fingers off the work, and use clean cotton cloths.

Small parts of guns which will not be injured by a little heating may be blued by the following process: First remove all the oil and grease by the method described above. Attach a wire to the work to handle it by if necessary. Obtain an iron pot like the pot one melts lead in for moulding bullets. You also want some arrangement for heating the pot very hot, such as a Bunsen burner, gas stove, or Primus stove. In the pot place—

Potassium nitrate .....10 parts
Sodium nitrate .....10 parts
Dioxide of Manganese..... 1 part

Mix these and heat in the pot. They are powders, but will start to melt and become liquid at about 650 degrees F. At 700 degrees the liquid will start to move slowly and gently in the pot. At 750 degrees this movement will be increased to a slight agitation somewhat like water boiling gently but without bubbles. This is just the temperature you want, that is between 700 and 800 degrees F.

The work having been polished and freed from oil as described, hold it on a wire, or place in a wire basket, submerge it in the hot liquid, but do not let it touch the bottom of the pot. It should stay in from two to four minutes in all. Take the work out after a minute or so and you will notice the blue color creeping over it. Put it back and leave it in the bath until the right color is obtained. Do not leave it in too long, but take it

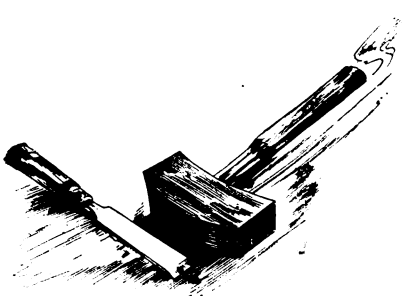
out as soon as right. If left too long, or if the solution is too hot, it may turn brown. Immediately after taking the work out quench it in warm water (130 to 150 degrees F). Do not have the water too hot or it may turn the work slightly brown.

Remember not to use this process on any tempered parts such as firing pins, strikers, or sears. Such parts had better be left bright, or else blued by the process recommended for barrels, even if this process is a little tedious. This heat process is all right, however, for such parts as hammers, carriers, magazine followers, butt-plates, pistol grip caps, barrel bands, sling swivels, etc.

Sights are best blued by a process which leaves them a dead black that does not glisten or shine. First clean the sight free from all oil as described for barrels, and attach a wire to handle it with. Prepare a solution of 1 part of nitric acid to 7 parts of water in a china or earthenware cup. Immerse the sight in the solution. After a few seconds the bright polished surface will assume a dull leaden look, and the solution will become slightly discolored immediately around the metal. Gradually the smooth look will give way to a finely pitted appearance. In about three minutes the action of the acid should have sufficiently pitted the sight very finely all over. Keep the sight moving a little so that all portions will be equally pitted. Then take it out of the solution and plunge it into a kettle of boiling water. Let it remain in this for a minute, and then take it out and plunge it into another kettle of boiling water, stirring it around and allowing it to remain for about five minutes. Finally put it in a third kettle and let it boil in water for fifteen minutes. All this boiling is absolutely necessary in order to completely stop the further action of the nitric acid. If the washing be

hurried the chances are that red spots and streaks will appear in the next step.

Next, after wiping the sight dry with a cotton cloth, proceed to blacken as follows: Twist a piece of iron wire around the sight to handle it with. Hold it in a gas flame and carefully watch the color. At first it will turn straw color, then brown, after that a dark brown, and lastly a bluish color, when it should be removed from the flame and plunged into oil. If allowed to pass the bluish color it will become white with heat, and this is undesirable. After allowing the sight to cool in the oil, remove it and the black ought to be dead black, that is, not shining, due to the finely pitted surface of the metal.



CHAPTER VI.

Fitting Sights and Telescope Bases.

IT is quite a little problem to get the sights mounted on the rifle, or telescope sight bases screwed to the barrel so that they are absolutely straight fore and aft, in perfect alignment, and truly vertical above the axis of the bore. We often see work of this kind which has been done in a very slovenly manner, and besides not working satisfactorily, a poor job of this kind disfigures the whole weapon. Even professional gunsmiths are frequently guilty of negligence in these matters. Poor work is usually the result of trying to align the sights or bases in their correct position by eye, alone, or in spotting the location for the screw holes by crude and inaccurate methods. It is intended here to give proper methods and principles, which, if adhered to, will always result in the correct placing and mounting of the sights if pains are taken to be accurate.

Before we begin with the problem of mounting, the under surface of the sight or base where it comes in contact with the barrel or receiver must be correctly shaped. For example, telescope sight bases must be milled so as to have the same radius and taper that the barrel has at the place they are to be mounted. Similarly the under side of the sights must fit snugly and properly to the rifle at the location where they are to be mounted. This is usually attended to in a very perfect manner by the manufacturer of the sights. The makers of telescope sights can usually furnish bases which are correct for mounting on the barrels of any particular standard rifle. But occasionally one wishes to mount a

certain sight on a rifle for which it was not particularly designed, or he may have made his barrel of a certain size which differs so much from the regular commercial size that no telescope bases are regularly made to fit it. For example, it is easy to fit the Lyman No. 48 receiver sight to many rifles besides the Springfield. It can easily be slightly altered as to its base so it will nicely fit on the Krag, Mauser, Enfield 1914 and 1917, and Winchester Model 52. On some of these it is best to place it on the left side of the receiver, reversing the eyepiece. The first thing to be done, therefore, is to see that your sight or telescope base fits the metal of the rifle snugly and correctly where you are to mount it. If it does not you must make it do so by slightly altering the contact surface of the sight, either in a milling machine or with a file. Mechanics blue may sometimes have to be used here to secure a correct fit in the same way that you used it to obtain a correct fit of the wood of the stock to the metal parts of the rifle.

Leveling and Truing Sights and Spotting Screw Holes.

The next problem is to clamp the sight or telescope base to the rifle in the exact position where it is to go, level and correct, straight, and true, and then to locate and spot the correct position for the screw holes that you have to drill and tap to secure it to the rifle.

To so locate we have to have something for reference by means of which we can always tell if things are in line. This something is a surface plate, or a smooth and level table or board. Place the barrel and receiver on this, resting the barrel in "V" blocks as shown in Fig. 13. Now we must get the barrel and receiver absolutely vertical on this plate. This is usually done by taking

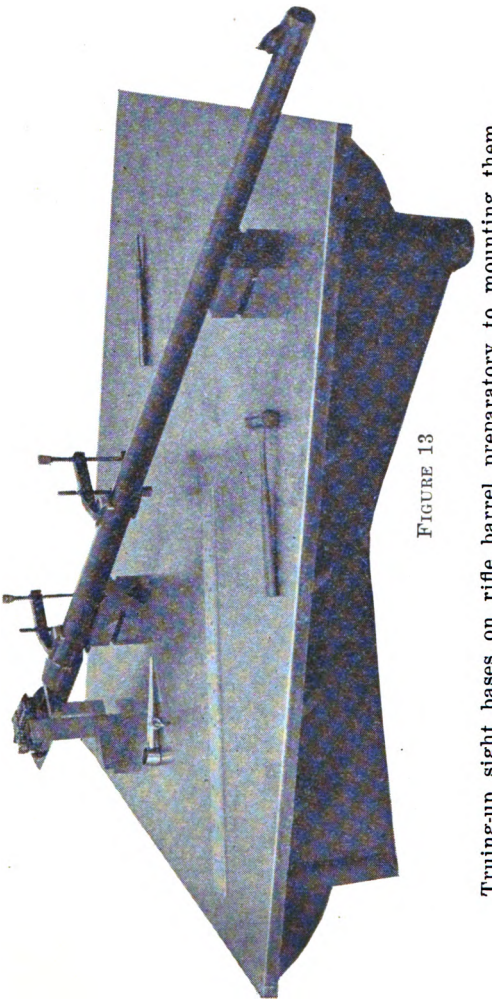


FIGURE 13

Truing-up sight bases on rifle barrel preparatory to mounting them.

some square surface, usually on the receiver, and getting it parallel or at right angles to the surface plate by means of small steel squares. For example, Fig. 13 shows the barrel and receiver of a Winchester Model 52 rifle being laid vertical by making the square surface of the top of the receiver just in front of the bridge parallel to the surface plate by applying two squares until their vertical edges are parallel. On Springfield and Mauser actions a square surface for doing this will be found on the under side of the receiver. On most single shot receivers the sides of the receiver are used, and the squares simply placed upright on the surface plate and its vertical arm brought up and the receiver trued up against it. Two

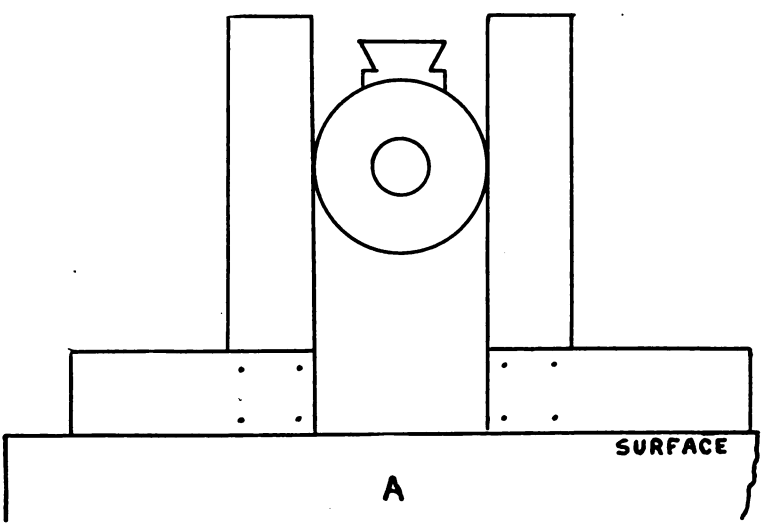


FIGURE 14-A

small squares and a little ingenuity will solve almost every problem. With some rifles and shotguns it is best to try to align on two square surfaces, and if there is any difference divide it equally.

Having once gotten the barrel and receiver truly vertical with respect to the surface plate, they must be carefully so maintained until the sight or base is securely clamped in its correct position.

Now carefully clamp your sight or base in its approximate position, using a parallel clamp as shown in Fig. 13. The clamp is not to be screwed up very tight at first. Now you must get the sight or base absolutely correctly placed. This is easiest described for the telescope base shown in the photograph, and the same principle will

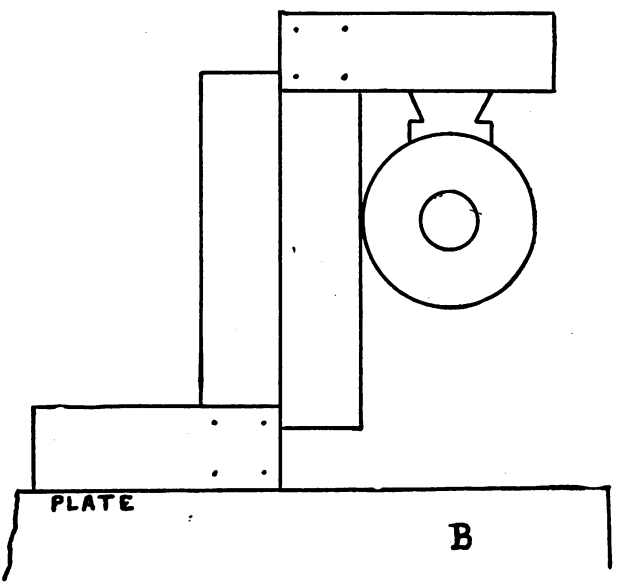


FIGURE 14-B

apply to a sight placed on either barrel or receiver. Place a square on either side of the barrel and touching it as shown in Fig. 14, A. With inside calipers carefully measure from the square to the side of the base on each side so as to be sure to get the base absolutely in the center of the barrel. Do this at both the front and rear end of the base. Then change the position of the squares to that shown in Fig. 14, B, and see if the top surface of the base is absolutely level and parallel to the surface plate.

Now suppose it is a Lyman No. 48 receiver sight that you wish to attach. Clamp it in approximate position on the receiver. With the square on the surface plate true up its side surface so as to get it straight one way, and then true up the rear side of its base in a similar manner so as to get it straight fore and aft. With this sight sometimes the rifleman may wish to have it inclined a little to one side at the same angle as the drift angle on the service sight so as to automatically allow for drift as it is elevated. This is a nice little job, but can easily be accomplished with a pair of delicate calipers by using lots of patience.

Having gotten your sight or base in its absolutely correct position you then clamp up tight with the parallel clamp so that there is no danger of its getting out of adjustment. In order to enable you to verify this adjustment from time to time it is well to scratch a slight line at front and rear on the barrel or receiver so you can tell at any time if the sight has moved. Now you are ready to spot the holes for the screws.

There are usually two screw holes through the sight or base by means of which it is secured to the rifle by screws. We now want to locate a spot on the rifle exactly

in the center of these screw holes. This spot marks the point where the drill must be started which drills the hole in the receiver or barrel for the screw. To get this spot in the correct place it is best to use the sight or block itself as a guide. So take the barrel and receiver off the surface plate, and place it on the plate of the drill press, or if you are using a breast drill place it in a heavy vise in position for drilling. Use a drill of the same diameter as the screw holes in the sight or base. Start the drill down straight through the hole, and using the hole as a guide, drill a spot in the rifle underneath which will be absolutely central and correct for your screw hole. Having spotted the two holes in this manner, being sure that the parallel clamp has not permitted the sight or base to move a particle all this while, it is usually best and most convenient to loosen the parallel clamp and remove the sight or base for the rest of the drilling and tapping.

Drilling and Tapping.

Usually the sight-makers furnish the proper screws for attaching their sights and bases to the rifle, and you can also usually obtain from them drills and taps the correct size for these screws. If you have to provide your own screws, you will find that in most cases 7 x 36 Fillister head screws are about correct. You can get these from any good hardware dealer, and at the same time you should get the correct drills and taps for them. Start the drill down absolutely straight, starting it in the spot hole, and taking care that at the start it does not walk out of the hole. The depth to which you are to drill depends upon the dimension of the place you are drilling in. Obviously you must not drill through a

barrel so as to have the drill enter the bore. I have actually seen this done several times through gross carelessness. Go slow and use a depth gauge to tell you how deep you are. You must go deep enough to get a good bite for your screw, which usually requires ⅛-inch at least, and better 3/16-inch. Taps usually come in sets of three, numbered 1, 2, and 3. In this kind of work it is usually best, after the hole has been drilled to the correct depth, to start with tap No. 2, and after finishing with it, to complete with tap No. 3, thus getting the thread cut squarely to the bottom of the hole. This being completed you are ready to screw your sight or base in place. Dip the screws in oil or beeswax before driving them home, and use a correctly sized screwdriver so as to avoid marring the heads.

Telescope Sight Bases.

Two bases are required for attaching the mountings of a telescope sight to the rifle, and they must be the correct distance apart and in alignment with each other. The distance apart of the bases must be carefully calculated so as to give a logical and convenient reading to the adjustments of the mountings. For example, the bases for the Winchester A-5 telescope with No. 2 rear mount should in most cases be 7.2 inches from center to center as this makes each point on the elevation and windage dials have a value of half a minute of angle. That is moving the mounting one point changes the point of impact half an inch at 100 yards, 1 inch at 200 yards, and so on.

To see that the two bases are in absolute line with each other it is best to use a steel rule that is in good

condition. Apply this rule to the sides of the bases and see that it touches both bases equally for their entire length, thus showing that they are in line. Both bases should be fitted at the same time while on the surface plate, and the screw holes for each should be spotted at the same time.

Drilling on Hardened Receivers.

It often happens that one wishes to mount a receiver sight on a receiver, but the receiver may be heat treated or case hardened so that the surface is so hard that neither drill or file will enter it. This is usually the case with the military bolt action receivers, and with the older sporting rifle receivers. Modern sporting rifle receivers are usually soft enough to permit the drill to enter without trouble. When the receiver is hard the spot where the drill is to enter must be annealed by heating and slow cooling so as to soften it, but the softening must be at this one spot only, otherwise you might weaken the texture of the steel so it would not withstand the strain of the breech pressure. The method of doing this is called "spot annealing."

First clamp your sight in position on the receiver, getting the position fairly correct by eye, but not going to the trouble of perfect alignment with the surface plate. With a scriber, mark or scratch on the receiver the location where the screw holes are to come. Remove the sight and with a piece of emery paper polish the two places where the screw holes are to be drilled, so as to remove all bluing and leave the spots bright and smooth. Thus you have two little bright spots on the receiver at the approximate location where the screw holes are to be. Get a small piece of thin sheet asbestos about 3

inches square. Drill through it two holes corresponding to the two holes in the sight base. Securely tie this sheet over the receiver so that the two polished places that are to be annealed can be seen through the holes in the asbestos sheet. Now wrap wet cloths all over the receiver, and around the edges of the asbestos sheet, so that you finally have a bunch of wet cloth around the part of the receiver on which you are working, with a sort of hole in the mass of wet cloth in the bottom of which the abestos sheet is visible for a diameter of about 1½ inches, including the two holes where the annealing is to be done. To anneal use a gas burner and a blow torch. With the torch blow the flame into the holes in the asbestos so that the steel under these holes becomes very hot. Continue blowing the flame into the holes until the polished places on the receiver become a very dark blue in color, and then allow the receiver to cool slowly. This will anneal or soften the receiver surface right at these holes so the drill will enter without difficulty, but will not injure the hardness of the surrounding metal. You then put the barrel and receiver on the surface plate, true up, clamp on the sight, true that up, spot your screw holes, and proceed as before.

Although Springfield receivers are usually pretty hard, on many of the present issue it is not necessary to go to all this trouble of spot annealing. Place the sight on correctly on the surface plate, and then instead of trying to spot the hole by starting a drill down through the hole in the sight, use a scriber and carefully scribe a circle on the surface of the receiver, making the scriber follow around the bottom of the screw holes in the sight base. Remove the sight base from the barrel and you

have two little circles accurately scratched on the surface of the receiver just where the screw holes are to be drilled. You can easily locate the exact center of these circles where your spot for drilling is to come. Use a very sharp and hard prick punch, and with a smart blow of a hammer drive the point of this punch down into the receiver metal at this center mark. Usually two or three smart blows will suffice to get through the hard skin of the metal, and leave a decided hole there. But the prick punch must be both sharp and hard. After each blow, if you have not gotten through, sharpen the point of the punch on a grinder before striking again. When you have gotten this hole, which you usually do the first time you strike, start a small, sharp drill in it. This opens it out enough so that the regular drill can be started without trouble.

The old fashioned sight slot is very poor method of securing a sight to the barrel. It is used because it is cheap. Where possible it should never be used for a rear sight because a slot in this portion of a barrel weakens the barrel so as to introduce undesirable vibration when the rifle is fired and make it cranky in its shooting, or even inaccurate. But sometimes no other method is available, and slots must be used. The best method of cutting a slot is to do it on a milling machine, but if the amateur is skilled in filing he can do it with a 3 cornered file if he takes plenty of time and uses lots of patience and care.

Put the barrel on the surface plate from time to time and see if you are cutting level and square across. This dovetail slot should be cut in the barrel without any taper, and its width and shape should be just right so as to admit the left side of the base of the sight

entering about ¼-inch into the slot. The dovetail base on the sight is made on a taper, the left side being the smaller, so when it is driven into the barrel slot from the right to the left (facing towards the muzzle) it wedges itself tight in the slot. Always drive such slots in from right to left, and out from left to right. In driving, secure the barrel right at the muzzle in a heavy vise so that there will be no danger of the blows of driving bending the barrel, and drive with a copper rod against the base of the sight.

Aligning Sights.

When locating and placing front and rear sights on a rifle it is very desirable to place them in so nearly correct alignment that the rifle will be approximately sighted in for the shortest range at which it is likely to be used. You don't want to have the sights so out of line that it is afterwards necessary to move one or both way to one side, neither is it nice to find that you cannot get your rear sight down low enough to strike anywhere near the bull with a 6 o'clock hold. To align the sights approximately correct they should be made to line up with the axis of the bore. This is easiest accomplished by removing the breech bolt from the action so you can see through the bore and sight through the sights at the same time. Put the rifle in a rest or vise where it can be aligned on a target 50 yards or over distant. Align the bore on the bull's-eye by sighting through the bore until you see the bull through it. Holding the rifle steady and immovable now bring the sights into the same alignment with the center of the bore and secure them. This will be their approximate alignment for point blank range.

Usually when the sights are aligned this way the rifle, on firing it, will be found to to shoot slightly low, but it is better to have it this way because the fault is easily corrected by elevating the rear sight or filing down the front sight. I would advise you to first fit an ordinary steel front sight. Then you can file this sight down until it is just exactly the right height to enable you to use the rear sight at its lowest elevation for your shortest range. Then take this steel blade out of its base, and send it to the sight maker, asking him to make an ivory or gold bead front sight of the same size and height.

In thus aligning the sights see also that they are the correct height above the top of the barrel. They should not be too high, and yet they should not be so low as to cause glimmers and heat waves from the barrel to interfere with the aiming. If the line of sight passes about $\frac{3}{16}$-inch over the top of the receiver breech the height is just about correct. Our forefathers had the sights on their Kentucky rifles very close to the barrel, but there were reasons for this which do not pertain today. They shot mostly in the deep forests where there was no glimmer from the barrel to interfere. The barrel did not get heated up in the cool forest or from the heat of rapid firing. Their rifles were charged for deer, but they usually obtained the majority of their shots at small animals and birds at very short range, so they wanted a line of sight very close to the bore so they would not under or over shoot when aiming for the heads of grouse and squirrels. One of our companies once made the mistake of placing the sights very close to the barrel following out this old custom. This was on a very thin high power barrel. After a shot or two the barrel heated

up, and the waves that arose made aiming almost impossible. They soon changed and placed higher sights on the rifle.

Barrel Band Sights.

The best method of securing sights to the barrel of the rifle is by means of a band which encircles the barrel, this band having a base on its upper side to which the sight proper is secured. The bands should be a close fit to the barrel, but should not be so tight that they have to be driven on or they will interfere with the expansion of the barrel at that point. They are pinned to the barrel by a pin passing through the band and biting into the barrel about half its diameter. The making of a sight base and band is a very extensive lathe and milling job, requiring the knowledge of a good mechanic, but such sights can often be had which are made for military rifles, and it is easy to attach them to many barrels other than the ones for which they were designed. For example the front sight band and sight base for the Springfield rifle can be attached to the great majority of our sporting rifle barrels by slightly turning down the diameter of the barrel at the muzzle to fit it. Other sights with bands can often be obtained from dealers in obsolete military arms. Such sights should be assured in their vertical position on the barrel by placing the barrel on the surface plate as before, and getting the sights absolutely vertical before pinning it.

Removing Barrel Bands.

One often wishes to place sporting sights on a military rifle, but the rifle may have its regular military sights secured to the barrel by bands, and it is often quite a puzzle to know just how to remove these bands.

The pins which secure these bands to the barrel may be so concealed by the bluing that it is difficult to find them. On the Springfield the pin securing the front sight band to the barel is on top of the band near its rear end. This must be driven out with a drift pin, driving from either side. As the ends of the pin are upset to secure it it starts rather hard, but perseverance with correct centering of the drift pin at each blow will bring it out. Have the muzzle in a heavy vise while driving so that there will be no danger of the blows of the hammer bending the barrel. After removing this pin, drive the band straight forward off the barrel. The band of the rear sight fixed base is similiarly secured to the barrel by a pin which goes through its under side about $\frac{3}{16}$-inch in rear of the forward end of the band. It is usually pretty well hidden by the bluing, and the location should be slightly polished with emery paper to disclose its exact location. Drive this out in the same way with a drift pin, driving to either side. Its ends are also upset and it is liable to start hard. After removing it, drive the band straight forward off the barrel.

The sight bands of a number of foreign rifles, particularly German military rifle, are liable to be soldered to the barrel by a low fusable solder. Some of this solder is designed to melt by applying boiling water to the parts, and others by applying a small amount of dry heat. First try pouring boiling water over the band for several minutes and then try to drive off to the front. If it does not come with boiling water, try heating it slightly in a gas flame, but never enough to anneal it; that is, do not apply enough heat to change the color of the band, and particularly the color of the barrel if you care for the barrel at all. After barrel bands have

been removed there will usually be a rough unpolished surface of the barrel under them which must be turned down slightly, polished, and the barrel blued as described in previous chapters. This pertains more particularly to the surface under the rear barrel band. Of course if you are going to replace the front barrel band the surface of the barrel under it should not be touched.

Making Forearm Barrel Bands.

The best method of securing the forearm to the barrel, particularly on a bolt action rifle, is by means of a barrel band. The band encircles the barrel about 2 inches in rear of the tip of the forearm. On the under side of the band, and hidden by the forearm, is a lug. A screw passes through a metal bushing in the forearm and into this bushing on the band, thus securing the forearm to the bushing and band, and retaining it in close contact with the barrel at all times. This screw often has an eye on its head, this eye being used to secure the gunsling to the forearm. The band which goes around the barrel should not be a tight fit or it will restrict the expansion and lengthening of the barrel as it heats up, and may interfere with the accuracy. The barrel usually tapers slightly at the point where this band encircles it, and it is best to make this band of such inside diameter that it is a correct fit for the barrel at a point about one inch nearer the breech than the exact place where it is designed to be. It will then be just slightly loose on the barrel when put in place.

The band should be made of soft sheet steel, or a hack saw blade which has been annealed and the teeth ground off could be utilized. It should be from ¾ to ½ inch wide, and should pass around about three fourths the diameter of the barrel. On the under side of the

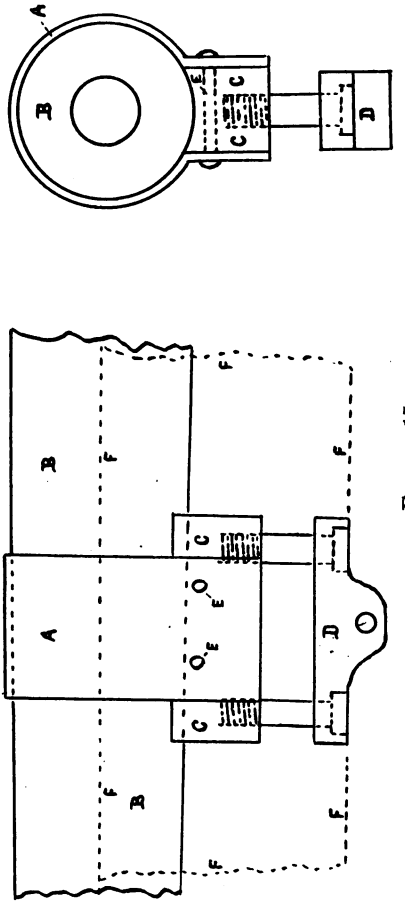


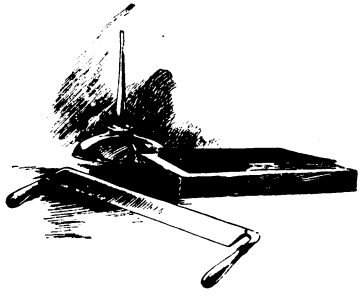
FIGURE 15

Forearm and Barrel Band

A—Band.
B—Barrel.
C—Block.
D—Sling swivel base.
E—Pins holding band to block.
F—Outline of forearm.
Submitted by Byron H. Jennings, Apt. No. 4, Cliff House, Pullman, Washington.

barrel the ends of the band should be pinned or brazed to a block into which the screws which retain the forearm are screwed. Figure 15 explains this rather fully. The under side of the block where it comes into contact with the barrel must be milled or filed to the radius of the barrel so as to give a close contact. In the sketch two screws are used to secure the sling swivel base. If a sling is not to be used only one screw is needed, and this screw should pass through a bushing set in the lower surface of the forearm. This bushing will look best if made of silver or german silver.

In making up the complete barrel band, the band should be bent and sized around a mandrel which is just slightly larger in diameter than the diameter of the barrel at the point where the band is to encircle it. The band will then be just slightly loose when placed in position on the rifle and there will be no restriction to the expanding and lengthening of the barrel as it heats up from firing.



CHAPTER VII.

Adjusting Trigger Pulls.

PROBABLY the job that the amateur will most often be called to perform will be the adjustment of trigger pulls. Practically every rifle as it comes from the factory needs adjustment in this respect. Good marksmanship depends more upon perfect control of the trigger than on any other one matter. A trigger cannot be perfectly controlled if it drags, jumps, grates, creeps, or varies in the amount of pull required. It is good only for very slow fire if it is too heavy. It will often go off prematurely if it is too light. In any of these cases the trigger will often confuse the marksman, making him believe that the rifle is going to be discharged when it is not, and thus introducing flinching.

An experience of many years in practical target and game shooting has taught us that the very best pull for all around use is one that requires a pressure on the trigger of from 2½ to 4 pounds to discharge the rifle. Some men can do their best work with a lighter pull than others, but practically all will find after they have become good shots, that their best pull will be found between these limits of 2½ and 4 pounds. The pull should be clean and without any suspicion of drag or creep. That is, the trigger should not move in the slightest until it releases the firing pin or hammer. It should give way suddenly without any preliminary movement, somewhat like the breaking of a thin glass rod. It is this kind of a pull we want to get when we start out to adjust a trigger.

Triggers, both from the standpoint of their mechanism, and their action under the impulse of the trigger finger, can be divided into three classes—(1) The Plain Trigger, (2) The Bolt Action Trigger, and (3) The Set Trigger.

An example of the plain trigger is seen in hammer rifles and most shotguns. The trigger is either entirely loose in its guard, or is stationary therein. As soon as one starts to press or squeeze the trigger it remains entirely stationary until it releases the hammer or firing pin, then it gives way suddenly (or rather should do so) and the rifle is discharged. As a rifle with such a trigger comes from the factory the trigger most usually requires entirely too much pressure to be applied to it to discharge the weapon. Sometimes it pulls off at from 5 to 7 pounds. Also less frequently it may have a drag or creep, giving way just a little bit after a pound or two of pressure and making the marksman think that the rifle is going off. The result is that the marksman instinctively sets his muscles against the recoil, and the outcome is a flinch. The perfect trigger squeeze is only accomplished when the marksman does not know the very instant that the rifle is going to be discharged, that is when the trigger gives way instantly in response to a steadily increasing pressure, and gives no preliminary warning. (See Chapter IV, Rifle Marksmanship.)

To lighten a trigger pull and eliminate the drag or creep, the amateur will require a good oil stone with flat surface, several small slips of oil stone, sheets of fine emery paper and crocus cloth, and a small spring scale similar to that used by a fisherman to weigh fish, which will record weights by quarter pounds from zero up to about seven pounds. There may also be needed a sharp prick punch, a hammer, files, and of course a screw-

driver for dismounting parts of the trigger mechanism.

Figure 16 illustrates a simple trigger mechanism, showing the trigger and hammer, the latter having the half cock and full cock notches. In this case the sear is a part of the trigger itself, but sometimes a separate sear is interposed between the trigger and the hammer as in Figure 17.

If it is desired to lighten the trigger pull examine the contact surfaces of the sear and the notch in the hammer. (See Fig. 16.) If the pull is heavy it will be noticed that these surfaces come together on a line similar to A-B; that is the sear, to release itself from the notch, has to act strongly against the tension of the mainspring. This means a heavy pull. Also the sear may be too deep in the notch, requiring it to do a lot of lifting before it disengages itself. The contact surfaces of the sear and notch should be ground so that they come together more on a line like C-D so that pressure has to be applied only to slide the sear out of the notch, and not to force the hammer further back against the mainspring. Also the sear should in many cases not bite so far into the notch in the hammer. Dismount the hammer and sear or trigger, and grind the two contact surfaces so that they come together on the line C-D, being careful to get this line just right by making the two parts take the same relationship that they do when assembled, noting the exact angle of this line of contact on each part, and holding this angle when pressing the part against the level

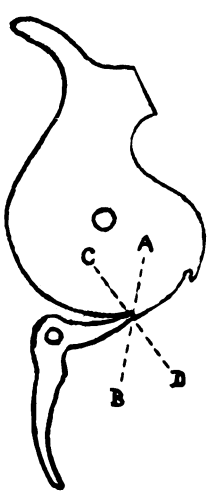


FIGURE 16

surface of the oilstone in grinding. Hold the part straight on the stone so as to grind no more on either side than in the middle. Some little skill is required to do this, and one must be constantly watching the angle at which he is holding the work against the stone, and telling by feel if he is grinding too much on one side. Go very slow, and assemble the parts often and try the weight of the pull by the spring scales, being sure that the scale pulls on the trigger in the same direction that the finger does, and that the hook of the scale is applied to the center of the trigger. Watch the scale as the pull is applied, and you can catch the maximum figure just before the trigger gives way. Again go slow with the oilstone, and try the pull frequently. When you are getting down to nearly the right pull often five or six light strokes on the stone is enough to make a great difference in the pull. The danger here is to grind too much and ruin the parts, and then have to wait until you get more from the factory. Usually very little grinding is necessary to lighten the pull to the desired amount, and also usually the novice grinds off entirely too much at the first attempt. Go slow and try often.

In many cases this is all that is needed to lighten the pull of a plain trigger, but sometimes it happens that the sear has too deep a bite in the notch of the hammer. When this is so do not attempt to work on the hammer notch, because if you were to grind down the projection on the hammer which forms the notch the chances are that the sear would come out of this notch before it had been depressed enough to clear the half-cock notch, and the result would be that the hammer, instead of falling all the way, would hang up, in the half-cock position. The grinding off of this standing portion of the notch must be guarded against also in changing an angle of the

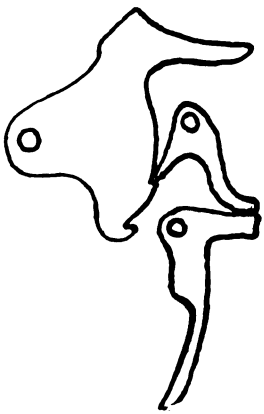


FIGURE 17.

notch as described above. The easiest way of preventing the sear entering the notch so deeply is to slightly prick-punch the hammer just in rear of the notch; as shown in Figure 18. The sear will then strike against the raised portions of the metal around the prick mark, and will not settle down so deeply in the notch. This is very easily done, and if it is overdone it is also easy to grind off the raised metal and prick again. The punch should be very sharp, and the mark should be as close to the raised part of the notch as possible.

If the trigger has a drag or creep it is usually because the sear enters the notch too deeply, and this method of prick punching in rear of the notch will usually cure this trouble. If it does not, then it is because the surfaces of the sear and notch, where they slide over each other, are not smooth, and the cure is to smooth and polish them on the line C-D, Fig. 16. It will thus be seen that the two operations described to lighten the pull, if properly applied, will also result in eliminating drag or creep.

BOLT ACTION TRIGGERS.

With the bolt action trigger the action is quite different from the plain trigger. Here we do not have a hammer, it being replaced with a cocking piece, and there is no half cock. When the bolt of such a rifle is forced forward and shut (a very quick and forcible operation particularly in rapid fire) the cocking piece comes hard

against the sear, and the contact surfaces of the two must be large and strong to stand the wear, and to prevent the cocking piece by any chance slipping by the sear and causing a discharge of the rifle in the act of closing the breech. Figure 19-A shows how these two surfaces come together at this time. It is obvious from this illustration, however, that if the trigger had to pull the sear way down through all this contact with the cocking piece, we would have a painfully long drag to the trigger pull, and a most unpleasant pull. So the trigger is arranged to have two motions, quite appreciably distinct from each other. During the first motion the trigger moves to the rear quite easily on the application of about 1½ pounds pressure, its movement being about ¼-inch straight back. This is what is known as the slack in the trigger, and it will be obvious that this slack, and the consequent large contact at the start between the sear and the cocking piece, is absolutely necessary for the safety of a bolt action rifle. No attempt should ever be made to eliminate this slack or preliminary pull on the trigger in an attempt to make it pull like a plain trigger. During this taking up of the slack the sear is lowered in its contact with the cocking piece to the position shown in Fig. 19-B. Now—it will be noticed that the sear rests against the nose of the cocking piece very slightly, just as in the case of the plain trigger the sear rested in the hammer notch.

To lighten a bolt action trigger pull, and also to eliminate creep and drag, the first thing to do is to polish the contact surfaces of the sear and cocking piece where they come together on the line A-B, Fig. 19. Do this by polishing first with fine emery paper held on a flat board, and then with crocus cloth. Do not attempt to change the angle too much for if you do, you will get it so that

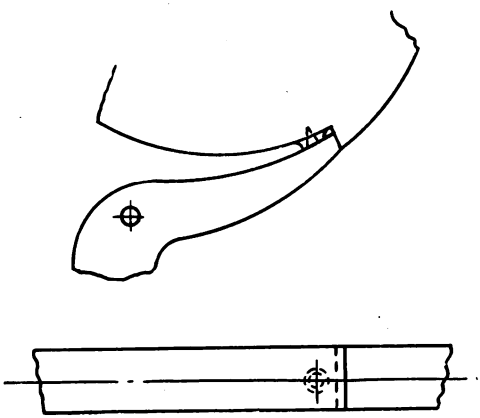


FIGURE 18.

if the slack be taken up on the trigger it will stand always taken up, and it will be unsafe to carry the rifle cocked. Simply polish them so that they will slide evenly over each other without any grate. Next you want to make this slide shorter, so grind slightly on the top surface of the sear C-D, going very slowly, and assembling the parts frequently, and trying often, so as to be sure that you do not go too far. Often the first operation will result in eliminating creep and making the pull light enough, but usually both operations are necessary. Sometimes, too, it is necessary to slightly change the tension of the sear spring. This spring is usually a spiral one, and it can be lightened by cutting off one coil slightly to shorten it, or by pulling it out longer with a pair of pliers and a vise to lengthen and strengthen it. It should always be strong enough to force a trigger, the slack of which has been taken up, back into its original position again.

SET TRIGGERS.

Set triggers are of many kinds. The most usual kind is the double set trigger, now mostly seen on German rifles. Ordinarily the front trigger pulls in the regular

manner, but if one first pulls the rear trigger back until it clicks, this sets the front trigger, and the latter will then release the hammer or cocking piece on the application of only an ounce or so of pressure. It is sometimes called a "hair trigger," because it requires only about as much pressure to move it when set as it does to move a hair. Other set triggers have two triggers close together, and to set the front trigger, the rear one is pushed forward. Then there is the single set trigger, in which the one trigger is pushed forward to set it.

The mechanical action of all these triggers is very similar. The action of setting it compresses and locks back a strong lever or hammer, the sear of this hammer being attached to the front trigger, and being very delicate. On touching the front trigger, this sear releases the hammer or lever, which then flies up, and with a blow, drives the true sear away from the true hammer or cocking piece, and thus causes the discharge of the weapon.

These triggers almost always have a small set screw which is usually located on the trigger plate, often between the two triggers. By means of this screw the depth with which the set trigger sear engages the knock off hammer or lever is regulated. By screwing this screw in or out any desired pull can be obtained from the set trigger.

As the mechanism of these set triggers differs considerably it is not possible to give any general directions for adjusting them. By studying the mechanism, however, it will be found that there is always a sear and a notch or shoulder, and that one slides over the other and disengages itself on exactly the same principle as the plain trigger or the bolt action trigger, and by applying the same principles as in lightening these last named

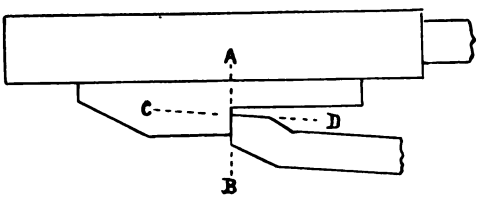


FIGURE 19-A.

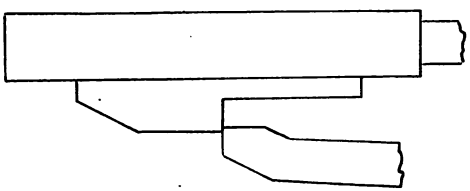


FIGURE 19-B.

triggers, no difficulty will be had in adjusting the set trigger. Usually, in fact, the adjusting screw takes care of all adjustment to the set trigger, and it is only the regular portion of the trigger, that is, the portion that operates when the trigger is not set, which requires adjustment, and the method of adjusting that is the same as described for the plain trigger or bolt action trigger.

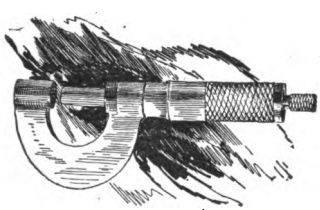
REVOLVERS AND PISTOLS.

The mechanism of practically all revolvers is similar to the simple trigger illustrated in Figure 16, and the directions already given apply to revolvers as well as to other weapons having triggers of this type. This, of course, refers only to the single action feature. The pull of the double action is governed largely by the strength of the mainspring and its leverage on the hammer, and in general no attempt should be made to change it. Revolvers are occasionally seen where the double action pull has been lightened by grinding the mainspring so as to make it thinner, and consequently weaker,

but this is not advisable, as misfires are a frequent result, and broken mainsprings are likely to occur. Revolvers of some makes have a small screw on the front of the grip-frame near the bottom of the handle. This is called the strain screw, and is for putting the tension on the mainspring after assembly. Some people will try to improve the trigger pull by loosening this screw, and so relieving part of the tension of the mainspring, but this is not a proper procedure, for the strain screw should be screwed all the way in for best results, otherwise the mainspring will not lie with the proper curve, and the action of the weapon will be impaired.

In the automatic pistols which have a hammer, such as the government model .45, the trigger action, though modified by the use of a separate sear, is similar in principle to that shown in Figure 16, and may be smoothed up in the same manner as already described. As automatic pistols are naturally dangerous weapons, care should be taken not to get the pull too light. One danger of having a very delicate pull on automatic pistols is that the jar of the action may cause the hammer to follow the slide. After the pull has been adjusted, the weapon should be tested by cocking the hammer, and, with the finger off the trigger and the grip-safety compressed, drawing back the slide and allowing it to slam forward several times as violently as possible. If the hammer follows the slide, that is, fails to stay cocked, the pull is too light. A light pull can sometimes be corrected by increasing the tension on the sear spring by bending it. Automatic pistols which have no hammer have a sear which engages a shoulder or notch in the firing pin. Most of these weapons have a mean, dragging pull, which in some constructions cannot be overcome, owing to the leverage, etc., employed in the design.

In other types it can be somewhat improved by carefully stoning the contact surfaces so that they will slide evenly and smoothly. In general, the depth of contact or the angle of the surfaces should not be changed, as in many automatic pistols, especially of foreign make, the safety only prevents the trigger from being pulled, but will not prevent the sear from jarring out of engagement with the firing pin in case the gun is dropped. When these pistols are loaded they are always cocked, and to alter the sear or firing pin might render the weapon extremely dangerous to carry loaded.



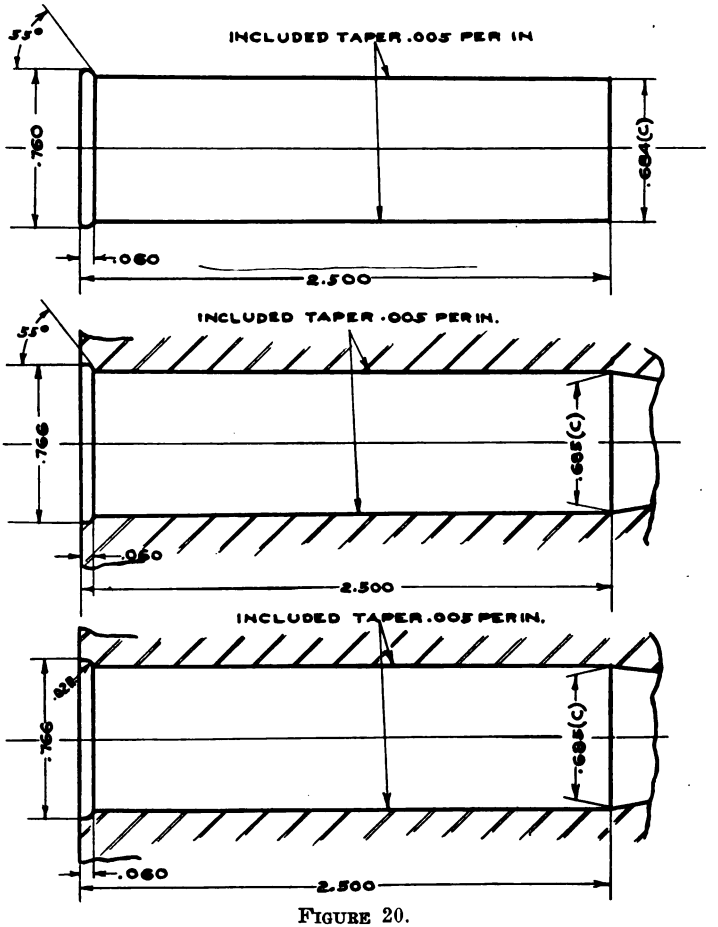


FIGURE 20.

Sizes of 20-ga. maximum shell and minimum chamber. Note: Angle on chamber counter-bore ranges from 55° to 90°; on cartridge head, 53° to 55°. Dimension "C" for cartridge and chamber is constant for all lengths.

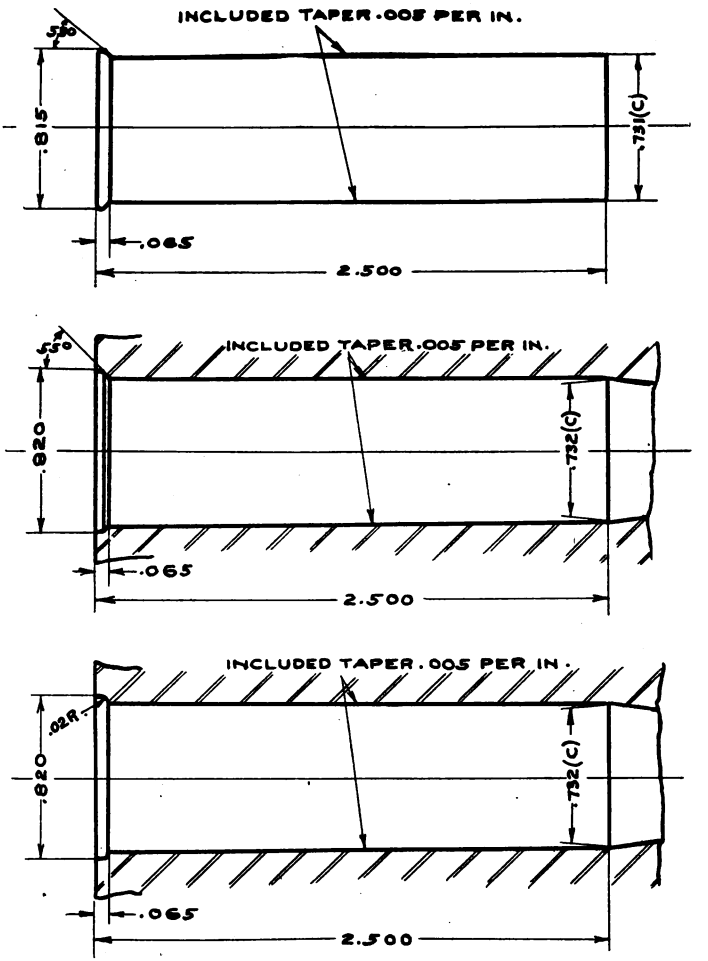


FIGURE 21.

Sizes of 16-ga. maximum shell and minimum chamber. Note: Angle on chamber counter-bore ranges from 55° to 90°; on cartridge head, 53° to 55°. Dimension "C" for cartridge and chamber is constant for all lengths.

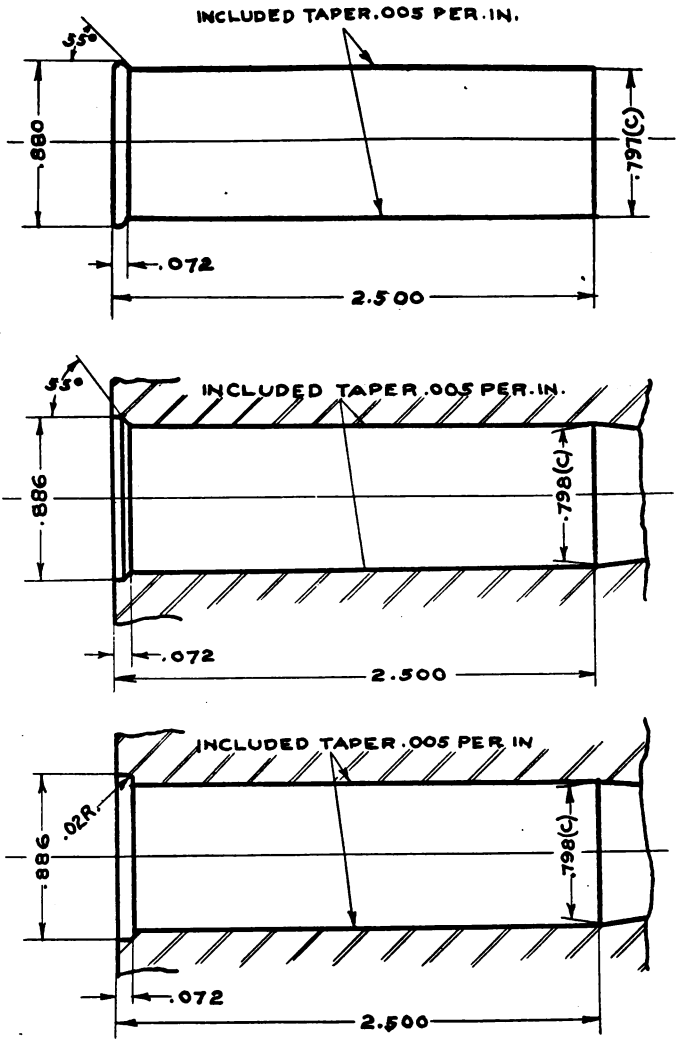


FIGURE 22.

Sizes of 12-ga. maximum shell and minimum chamber. Note: Angle on chamber counter-bore ranges from 55° to 90°; on cartridge head, 53° to 55°. Dimension "C" for cartridge and chamber is constant for all lengths.

CHAPTER VIII.

Shotgun Repairs.

IN making repairs on shotguns it is very necessary at the start that the amateur know how to take a shotgun apart and put it together again. It is very easy to injure a fine shotgun by going about this in the wrong way, or by using unsuitable tools. Instructions for dismounting shotguns can be obtained from the makers. The makers of repeating and automatic shotguns publish these instructions in their large catalogues. Find out all you can about the particular weapon before starting to work. A sectional illustration of the mechanism is very useful. You will find the following general instructions relative to double guns helpful.

Use the correct size screwdrivers to remove the screws so as not to mar the heads of the screws. Marred screw heads greatly disfigure a fine shotgun. Have a number of screwdrivers on hand, and if one does not fit a screw exactly file it down carefully to make it do so. First of all cock the locks. Then remove the screws from the rear tang or rear end of the trigger guard. The front end of the trigger guard is usually screwed into the action body or receiver by a screw which is permanently brazed to the guard. To remove unscrew the whole guard by turning it counter clockwise until it comes off. If the gun is a side lock model the side plates may now be removed by unscrewing the small screws which retain them in place. Be careful not to injure the surrounding edges of the stock as you lift them out of their place in the action body and stock. Next loosen the screws in the trigger plate, push the top lever to one side and remove the screw which has its head in the upper tang and runs

through to the trigger plate (trigger post). The trigger plate can then be removed by completing the turning out of its screws. Remove the remaining tang screws, and the stock can then be removed from the frame. Unless the locks are very dirty or rusty it is inadvisable to dismount them. They can usually be cleaned by immersing in gasoline, and dried with canton flannel or a chamois skin on a pointed stick. The fine locks on an expensive gun should be polished with chamois skin and oiled with watchmakers oil.

The hammers on a gun should never be left at full cock. Some hammers can be let down by holding the triggers back while closing the gun. Others can have the triggers let down by holding a piece of hard wood, copper, or lead against the face of the standing breech, and snapping the gun so that the firing pins come against the wood, copper, or lead, thus taking up the blow. A shotgun should never be snapped on an empty chamber. English makers of high grade guns provide dummy shells with spring plungers to snap on, and for snapping practice.

The following are the diameters of the cylindrical portions of the bore of shotguns:

4 gauge	= .935 inch	16 gauge	= .662 inch
8 "	= .835 "	20 "	= .615 "
10 "	= .775 "	28 "	= .550 "
12 "	= .729 "	410 bore	= .410 "

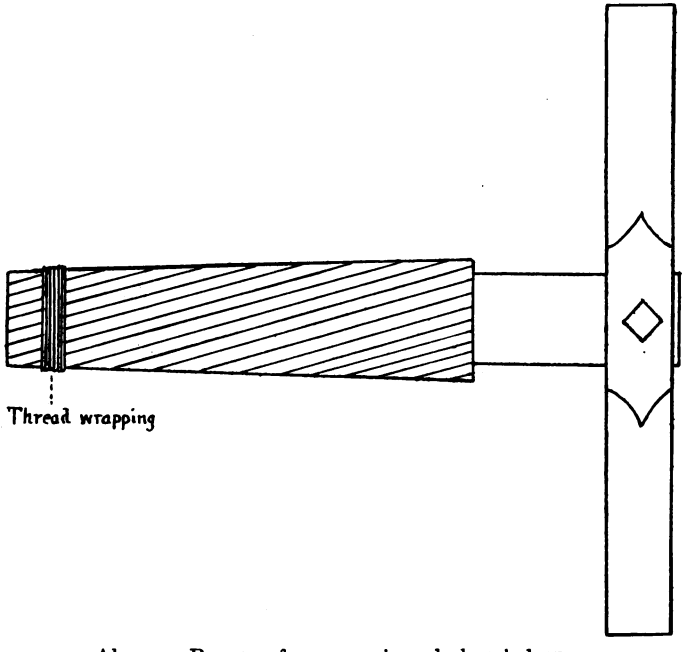
Many makers will vary from these dimensions slightly, in some cases as much as .01 inch, each manufacturer apparently having his own standard of boring. The exact size of a particular barrel can be determined by means of inside calipers, or you can whittle a piece of pure lead to size, drive it in through the chamber, upset it against a

steel rod inserted from the muzzle, and then carefully drive it out of the chamber end and measure it with a micrometer caliper.

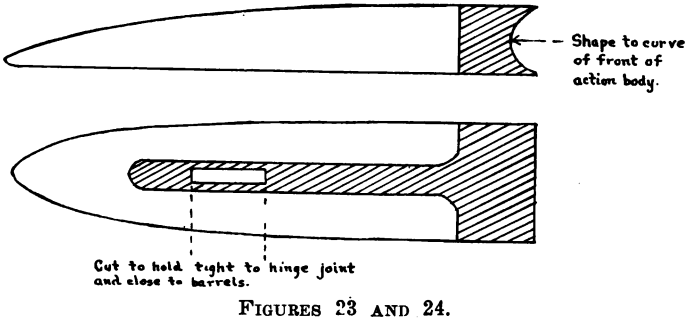
The choke in the muzzle of a shotgun varies from .01 to .04 inch. Each manufacturer has his own dimension and form of choke which he usually regards as a trade secret, but it is easily determined by means of an inside caliper and depth gauge. Usually the muzzle of a full choked barrel will measure about .025 inch to .035 inch smaller than the cylindrical bore, a modified choke will be about .018 inch smaller, and a so called cylinder bore about .01 inch smaller.

Figures 20, 21 and 22 show the standard dimensions of the maximum shell and minimum chamber of American shotguns as adopted by the Technical Committee for the Standardization of Small Arms and Ammunition.

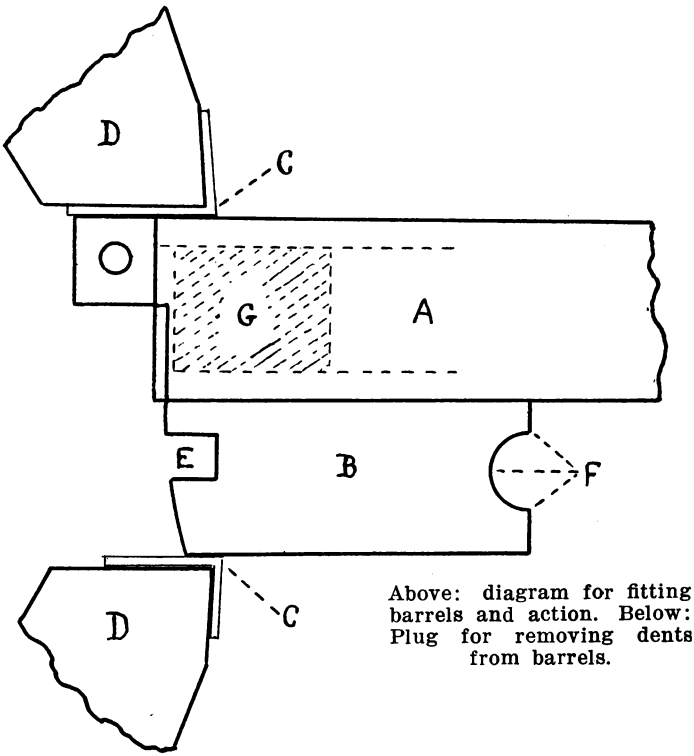
One of the most frequent repairs that the amateur will be called upon to do on a shotgun is removing dents from a barrel. Barrels frequently become badly dented from contact with iron or steel substances, striking against a wagon tire, or even by two sportsmen striking the barrels of their guns against each other. First measure the diameter of the cylindrical portion of the bore. Then turn up a plug of steel or brass, about 3 inches long and .001 inch smaller than the cylindrical bore as shown in Figure 26. Measure the distance on the barrel from the breech to the dent. Deduct 1½ inches from this measurement, and measure this length on the rod you are going to drive the plug with, and mark the rod at this point. Insert the plug at the breech and drive it into the dent with the rod and a hammer until the mark on the rod comes even with the breech of the gun. The dent will now be almost completely removed, and the plug will



Above: Reamer for removing choke; below: diagram for fitting fore end.

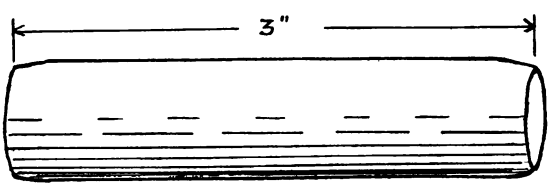


FIGURES 23 AND 24.



Above: diagram for fitting barrels and action. Below: Plug for removing dents from barrels.

A. Barrels
B. Barrel Lug
C.C. Brass Plates.
D.D. Jaws of Vise
E. Cut to be slightly closed by vise.
F. Pene to bring barrels against standing breech
G. Steel plugs in chambers.



FIGURES 25 AND 26.

be wedged in the bore with its center where the dent was. Now pene or strike the outside of the barrel over the dented portion with a lead hammer. This will gradually remove almost all evidence of the dent, and finally the plug will fall out of the bore. Damascus, laminated, and twist barrels are much more easily dented than modern steel barrels, and also dents are more readily removed from the old, soft barrels.

To remove the choke from a shotgun barrel, it is first necessary to make a reamer as shown in Figure 23. The smaller end of the reamer should be slightly smaller than the original diameter of the muzzle end of the bore, and should be wrapped with thread as shown to prevent the scarring of the bore below the choke. The larger end of the reamer should be just slightly larger than the dimension it is desired to open out the choke to. The reamer is inserted in the muzzle and turned until the choke is cut out to the desired size. Turn slowly and do not use much pressure. Stop often and measure to see how far you have cut, and each time remove all chips from the reamer and bore.

Broken or injured parts of guns often have to be replaced. Ninety per cent. of all firing pins are broken by the snapping of the gun when the chambers are empty. Hammers on hammer guns are often broken off by letting the weapon fall. It is always best if possible to send to the maker of the gun for the particular part needed for repairs. In the case of foreign guns, or guns no longer made, roughly forged and machined parts of all kinds can be obtained from Schoverling, Daly and Gales, 302 Broadway, New York, N. Y. They publish a catalogue of Foreign and American Gun Materials.

Parts should be made of tool steel. Firing pins can be filed and turned on a lathe from tool steel drill rod. To harden a tool steel firing pin, bring the point to a cherry red, dip it in oil, and then draw it in a gas flame to dark straw color.

To case harden a hammer bring it to a bright red heat, then dip it in a box containing cyanide (Potassium Ferrocyanide Crystals). The cyanide will hang to the metal. Put it back in the fire again and the cyanide will run all over it and will blaze and burn. The metal will look as though it had a coat of varnish on it. Bring the hammer back to bright red color and then drop it in water. This process can then be repeated exactly as before, and each time the skin of the case hardening will run deeper and deeper into the metal. It should not go in too deep, however, or the hammer will be brittle. About three applications are sufficient. Sometimes this method of case hardening gives a nice mottled color and finish, depending much on the kind of steel used.

Often cheap guns develop loose fore-ends, and the only thing to do is to fit a new fore-end. Good walnut fore-ends fitted with fore-end irons for double guns can be purchased from Schoverling, Daly and Gales. The first thing to do is to fit the circular hinge contour of the fore-end iron so it corresponds with the contour or curve at the hinge joint on the forward end of the action body. This requires most careful filing and polishing. Then the cut in the strap of the fore-end iron must be cut out so that it exactly fits the fore-end lug on the barrels, and brings the fore-end iron up very tight against the action body. (See Figure 24.) A very tight and careful fit is required here or the new fore-end will be no better than the old. Finally the walnut portion of the fore-end is carefully fitted to the barrel, checked, and polished.

Where it is desired to shorten a barrel or a pair of barrels, they should be marked all around with a scriber or other sharp instrument and a square, and should then be sawed off on this line as evenly as possible with a hack saw. The muzzle is then trued up with a file and a square, and the inside of the muzzles chamfered slightly to remove any slight feather edge. Then finish the job up neatly and smoothly with a fine file and emery cloth. If the weapon is a double gun the cutting off of the barrels will leave an opening between the barrels and the rib. Scratch the inside of this opening bright with a sharp instrument. Drive a little waste down inside the ribs so as to plug them up about one-quarter inch down from the muzzle, pour in solder flush with the muzzle, and finish up with emery cloth. Finally drill and tap a hole for the front sight, and screw the front sight in place.

Many of the action bodies and locks of our cheaper shotguns, those selling at prices under $25.00, are made of a soft, low carbon steel, not hardened or heat treated. At the price at which these guns are sold it is not possible to use the best of steel, nor to harden this steel properly after fabrication. As a consequence the parts wear gradually until the whole gun and its locks become too loose to function properly and with safety, and perhaps the trigger pull will become too light. In such case the parts should be reformed, reshaped, and adjusted with file and oilstone, and they should then be case-hardened as described above for hammers. Often nothing can be done with an old part, and a corresponding new part must be made of tool steel or obtained from the makers.

Mainsprings and top lever springs often break on such guns. The making of good springs is an art in itself, often beyond the capabilities of the average amateur, and

requires lots of experience. It is better to obtain a new spring from the makers of the gun, or from a dealer in gunsmithing supplies, and fit it with a file. Use a new, sharp file, and do not file the spring hard enough, or long enough at one time to get it so hot that the temper will be drawn.

The hinge joint and breech of a well made gun almost never comes loose. If it does it had better be returned to the maker to tighten up. Hinge joints and breeches on the cheaper grades of shotguns can be tightened in the following manner.

If the breech of the barrels do not fit tight up against the standing breech of the action body, take a hammer and slightly pene the semi-circular cut in the forward end of the barrel lug which fits over the hinge pin of the action body. This will bring the barrels back against the standing breech. Strike the metal lightly at first and try often—some of these lugs are made of pretty soft metal.

If the barrels do not fit down tight against the bottom of the action body, first turn up a couple of steel plugs which will be a tight fit inside the rear of the chambers, and put these plugs in the chambers to avoid all chance of forcing the breech of the barrels out of round. Use a heavy vise with brass lined jaws, and place the barrels in the vise as shown in Figure 25. Tighten up on the vise and the cut in the rear of the barrel lug into which the locking bolt fits will close up slightly so that when the barrels are assembled to the action they will be pulled down tight into place by the locking bolt. Here too you should go slowly and fit the parts together often.

It is best for the amateur not to attempt any repair work on automatic ejectors. This is really almost a watch maker's job, and unless a very skilled gunsmith is avail-

able, a good gun should be returned to the makers for any work on an automatic ejector.

Rubber recoil pads are easily fitted to a stock. The Silvers type of recoil pad has a hard rubber back, and is fitted to the buttstock with careful cutting and the application of mechanic's blue in the same way as a steel buttplate would be fitted. It is then screwed in place, and the head of the screw holes filled with the rubber plugs provided for this purpose. With the Jostam and other similar sponge rubber recoil plates, pull off the thin inner layer of the plate, tack this to the buttstock and then cement the recoil pad together again with rubber cement. All these recoil pads are made oversize and must have their sides trimmed down to conform with the sides of the stock. To do this neatly, replace the emery wheel with a wood wheel, to the side of which a sheet of sandpaper has been clamped. Revolve the wheel rapidly, and bring the buttstock and buttplate up against the revolving sandpaper, grinding the edge of the rubber buttplate down smooth and even with the buttstock. Finish neatly in a similar manner with a very fine sandpaper. Repolish the buttstock where the sandpaper has worn off the polish.

CHAPTER IX.

Revolvers and Pistols.

THE work and alterations which the amateur will most frequently be called upon to do in connection with revolvers and pistols is the refinement of trigger pulls, modelling of new grips which will better fit the hand of the individual, and alterations of the sights. The adjustment of trigger pulls has already been covered in Chapter VII.

Grips for revolvers and pistols are excellent objects for the amateur gunsmith to try his skill and inventive genius on. For one thing there is very little material to spoil, and experiment can be made with a number of walnut grips without running into much money. No extensive outlay of tools, work benches, or shop is necessary; in fact the whole thing can often be done almost in one's lap. And it promises so much, for a well-fitting set of grips moulded to the shooter's hand will greatly increase his skill with the weapon. It is just as important that the grip of the revolver or pistol fit the hand as that the stock of a shotgun be a good fit for the trap-shooter. One can also exercise all his artistic ideas in grips, carving and engraving them as he sees fit. Some wonderful works of art are seen in grips on pistols and revolvers, particularly those from the Orient and our Old West.

Grips are usually made of hard rubber or walnut, but can also be made of ivory, bone, or stag horn. They can be made in the usual conventional shapes and designs as seen on our existing factory weapons—for example, the amateur may admire the grip of the old single action Army Colt, and may wish to make a grip like it to go on his .38 Colt or Smith and Wesson double action revolver.

Or instead of making such a grip of walnut he may wish to make it of ivory and carve thereon the head of a steer as some of our old frontiersmen did. Again, some pistol shots may wish to depart entirely from conventional shapes, and model their grips to conform exactly to their hands, with grooves for each finger. It is easy to get such a shape to follow as a guide by placing large lumps of dental wax on each grip, then carefully taking hold just as one would in the act of aiming. The wax will then mould itself exactly to the hand, taking the imprint of each finger, and rising in ridges between the fingers. When this dries it forms a perfect model to follow in making the new grips.

Whatever the grips are to be made of, the blank is usually quite large at first, being fitted carefully to the metal parts before its exterior is shaped. In fitting to the metal parts the process is the same as that described in Chapter I, the cuts being made with chisel, knife, and file, constantly trying the grips on the metal tangs with a liberal use of mechanic's blue to get an exact fit. By using the old grips as a guide fewer mistakes will be made, and the work will proceed faster. Be sure that the two blocks forming the right and left grips have perfect contact over their entire inside surfaces outside the tangs where they abut against each other, otherwise when you come to shape them up for exterior shape you may open up an ugly crack or gap between them that you cannot hide. After fitting them perfectly drill the screw holes for the screws that hold them in place, and take the screw bushings from the old stocks and insert them in the new ones, or else obtain new screw bushings for this purpose from the makers of the revolver or pistol you are working on. Then go after the exterior, shaping and modelling it to suit your ideas. Finally check or carve it as desired,

and then, if it be a walnut stock, finish it as you would a gunstock (See Chapter III). One has to be quite careful in selecting walnut for grips of revolvers and pistols. Much of our ordinary American walnut is too soft and brittle for grips, and it splits too easily. Better try to get some genuine Circassian walnut.*

The next thing that will come to the amateur's attention is the sights. Most of our revolvers and pistols have very poor sights, some of them little better than no sights at all. Even the target revolvers and pistols have sights, particularly rear sights, which are made purposely with very small notches so that the owner can open them up and shape them as he desires. This opening up and shaping can easily be done with a file. You can get a set of small jeweler's files from the larger hardware houses in the big cities. Every amateur gunsmith should have a selection of these in rat tail, flat, half round, and triangular shapes. The sights themselves are so simple that new ones can easily be filed and shaped from tool steel or sheet metal. The most popular form of pistol and revolver sights for target shooting are those known as the Patridge. The front sight has a flat top, and the rear sight a square notch. When viewed in aiming, the flat topped front sight almost fills the square notch of the rear sight, flat top of the front sight just even with the top of the rear sight, and just a line of light showing on either side of the front sight. Figure 27 shows the Patridge sights in detail, and also their appearance in aiming. Notice how the front sight is undercut on the

*Smith and Wesson, Springfield, Mass., can furnish on special order large walnut blanks, milled accurately to fit their standard revolvers and single shot pistols. The amateur can attach these, and then cut and mould the exterior to any shape and design desired, thus saving all the time necessary to fit them to the metal parts.

surface near the eye to prevent any reflection of light towards the shooter, and to make the front sight always appear jet black when aiming.

The Patridge sights are usually at their best when used on black and white targets, that is, in target shoot-

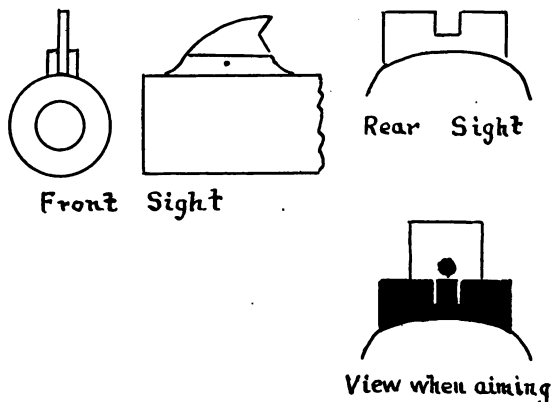
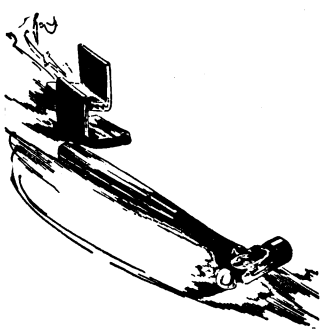


FIGURE 27.

ing, holding at 6 o'clock on the bull's-eye. They are not very good field or hunting sights. The best hunting sights consist of a gold bead front sight in conjunction with a flat top, open rear sight with a very wide "U" shaped notch. Gold bead sights for almost any type of American revolver or pistol can be obtained from our sight makers and easily attached by the amateur with screw or drift pin. The notch on the top of the frame, or in the rear target sight can be enlarged as desired with a rat tail jeweler's file. If enlarging or opening out the sighting notch cut in the frame of the ordinary revolver it is well to do the work in connection with the sighting in of the weapon on the target range. One can then get it as shallow or deep as desired, or cut it a little to one side or the

other so as to make the pistol hit where it is aimed on the target, a number of trial shots being taken from time to time when one is doing the filing. If desired a dovetail slot can be cut in the frame and a new rear sight fitted in it, but in cutting slots in the frame one must take care that he does not weaken the frame which bears much of the strain of firing.

Occasionally a revolver or pistol becomes disabled by the breaking of some part of the mechanism, usually a spring. It is much better and cheaper in the long run to send to the manufacturer for a duplicate part than to attempt to make it. The only tools necessary for replacement are a screwdriver and a few drift pins. On the cheaper weapons trigger pulls frequently wear too light. Now, it is very much easier to lighten a pull than to make it heavier, and in such a case it is easier, cheaper, and often quicker to send to the manufacturer for new triggers, sears, and hammers, than to try to make the old ones over to increase the weight of the trigger pull. When these new parts are assembled a very heavy pull usually results, and this can then be lightened and adjusted as described in Chapter VII.



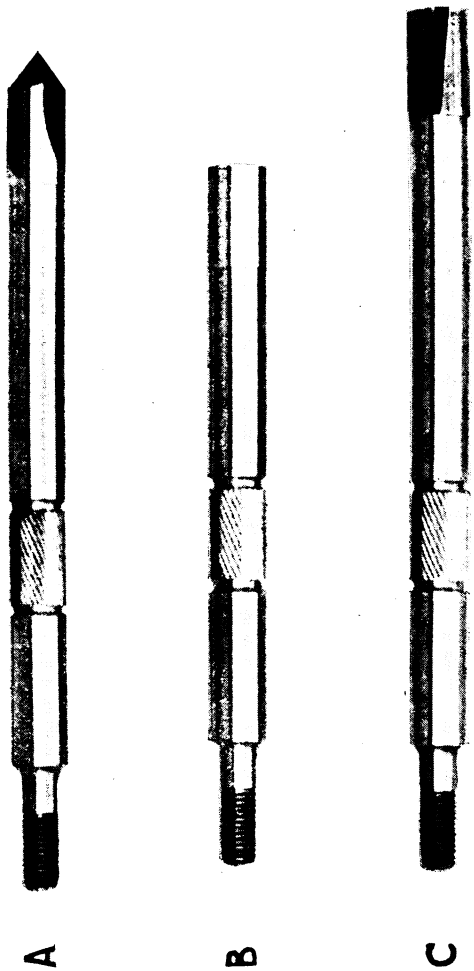


FIGURE 28.

CHAPTER X.

Measuring the Bore and Removing Obstructions.

IT is often quite important to know the diameter of the bore of a firearm. With rifle or pistol one should always know the exact diameter in thousandths of an inch of the bore and groove diameter. The bore diameter is the distance from the top of one land to the top of the opposite land, across the diameter. Similarly the groove diameter is the distance from the bottom of one groove to the bottom of the opposite groove. These dimensions will give one an indication as to the probable accuracy of a barrel for any particular kind of ammunition.

The Ordnance Department takes the measurements of the bores of Springfield and Krag rifles with an instrument called a "Star Gauge." This is a long rod, bored out to contain another rod inside of it. One end carries projections which fit into the grooves, and the other end carries a scale. The rod is inserted the desired distance into the bore, the scale pushed up until the projections come up tight against the bore on both sides, and the diameter read off the scale. Usually the bore and groove diameters are recorded for every inch of the bore from breech to muzzle, and thus all tight and loose places in the bore can readily be determined. A star gauged rifle is simply one that has been measured. Rifles selected by star gauging are merely those which have been measured and found to come within certain prescribed limits. Star gauges are very expensive, are not for sale, and are entirely beyond the capabilities of the amateur.

But there is another way to measure the bore of a rifle which is nearly as good. This is by driving a bullet

through it and measuring the diameter. Select a bullet of pure lead which is several thousandths of an inch larger than the expected groove diameter of the barrel you wish to measure. It should have a rather short bearing surface. For example, if you wish to measure a .30 caliber barrel about the best bullet to use is the regular factory lead bullet for the .32 W. C. F. cartridge. This bullet is short, of pure lead, and measures .311 inch, which is about .002 inch larger than the usual groove diameter of .30 caliber barrels. If you have no bullet of the correct size for the barrel you wish to measure it is an easy job to turn several up on a lathe. Clean the barrel thoroughly and lubricate it very lightly with a thin oil like "3 in 1." Have a stiff steel rod about ten inches longer than the bore and almost the diameter of the bore, with a square, blunt tip. (See Figure 28-B.) Slightly lubricate the bullet, drop it point first into the chamber, and with the rod shove it about an inch into the rifling. It may be necessary to hit the rear end of the rod a few light blows with a hammer to get it in. Insert the rod from the muzzle, and very carefully press the bullet out again at the breech. Catch it so that it does not fall and deform itself, and measure it with a micrometer caliper. This will give you the groove diameter of the barrel at the breech. In a similar manner push a bullet into the bore and with the cleaning rod shove or drive it straight through the bore to within about an inch of the muzzle. Hold the fingers at the muzzle so as to catch the bullet as it comes out, and holding the rod in the other hand, tap light blows on the rear end of the bullet, gradually driving the bullet out at the muzzle. Catch it with the fingers and measure it with the calipers, thus obtaining the groove diameter at the muzzle. In measuring the bullets,

always measure the greatest diameter from the raised portion which has been upset into one groove to the raised portion opposite. To obtain bore diameter, with a knife very carefully cut away the raised portions on either side of the groove that the lands have impressed on the bullet. Do this on either side of the bullet. Use a very sharp knife, and cut slowly and gingerly so as not to deform or upset the soft lead bullet. Then measure from the bottom of one groove in the bullet to the bottom of the opposite groove, and this will give you the bore diameter.

To determine the smoothness of bore and to detect and locate any possible tight or loose places in the bore, place the barrel in a heavy vise, using brass jaws so as not to mar the barrel. Force a bullet into the breech as before. Have a good big handle on the rod, or wrap it with a thick cloth. Take hold of the end of the rod and get the weight of the body behind it. Force the bullet through the bore with a steady motion, as slowly as you can without letting the bullet stop for an instant. It should take two or three seconds for the bullet to pass through. If it go through with an even and gradual speed, one can feel the difference in pressure which indicates tight or loose places. A little practice is necessary, and one should repeat this test two or three times to be sure of his findings. The best barrels are those which have no tight or loose places, but have even diameters from breech to muzzle, although most riflemen have the opinion that a rifle to shoot lead bullets will do better work if it gets just a very little bit tighter towards the muzzle, being gradually tapered.

To measure the chamber of a rifle it is necessary to make a sulphur cast. The chamber, and about one inch of the rifling forward from it, should be thoroughly

cleaned and should have a very slight film of light oil. Take a cork the size of the bore of the rifle, and drill a small hole through its exact center. In this hole place a piece of straight wire, about .0625 inch in diameter. Press the cork into the chamber and up about half an inch into the rifling, so that the wire extends through the cork and back to a point several inches in rear of the breech. The wire functions as a handle for the cast, as the cast is very brittle.

The mixture for the cast is to be made of the following materials:

Sulphur	2 ounces
Powdered lamp black	3 grains
Gum camphor dissolved in alcohol	3 drops

Heat very slowly and stir continually. When the mixture arrives at a thin pouring consistency pour it into the chamber quickly, and allow it to cool thoroughly before removing. To remove, place a cleaning rod in the muzzle and shove lightly on the cork, letting the cast come out slowly, and handling it very gingerly as it is quite brittle.

This cast can now be measured with micrometer and scale, and will give the dimensions of the chamber, as well as its shape. This mixture is almost shrink proof, but it is well to allow .0005 inch for shrinkage. Plain sulphur may be used instead of this mixture, but it shrinks more, and .002 inch should be allowed for this. It is important that the mixture be heated *slowly,* otherwise it becomes too thick to pour.

Removing Obstructions from the Bore.

There is no excuse for a trained rifleman ever getting an obstruction in the bore of his rifle or other weapon.

There is no danger of this if one takes the proper precautions and uses the proper materials in cleaning, and good ammunition. To avoid getting cleaning rods and patches stuck in the bore, the rod should have the proper size jagged tip (never a slotted one), only new canton flannel should be used for cleaning patches, and the patches should be cut to just the right size so that not more than five pounds pressure is necessary to shove them through the bore. If you use a field cleaner be careful of the size of patch you use with it, and inspect the cord frequently to see that it is not becoming worn or rotten.

Nevertheless novices do continually get obstructions in the bores of their guns, and the amateur gunsmith will often be called upon to remove them. The obstruction may be a cleaning rod and its patch, a .22 caliber bullet in a rim fire, or even worse, a field cleaner and its cord. I was once called upon to remove an obstruction consisting of a stick of wood about eight inches long, a large wad of cloth, and eight ten-penny nails, and the man said that he had not done a thing to his rifle.

When you get a rifle with an obstruction in the bore the first thing to do is to pour light oil in at one end, putting in a liberal amount, and letting it soak into the obstruction for about half an hour. Then reverse the barrel, and pour oil in at the other end and let it soak. Then thoroughly clean the bore from each end, down almost to the obstruction. It is then best to dismount the rifle and place the barrel in a heavy vise.

The amateur gunsmith should make two tips for his cleaning rod as shown in Figure 28. One of these tips

is formed as a drill (A) and the other (B) has a perfectly square end, the diameter being just slightly smaller than the bore diameter of the barrel. (This latter tip can also be used in driving bullets through to measure the bore.) Determine the location of the obstruction, and proceed to drive it out the shortest way, using the square ended tip, and driving with light blows of a hammer on the end of the cleaning rod. A little trial will tell one if the obstruction is going to come out by driving or not. In most cases this is all that is necessary, but in some cases it resists all attempts to drive it out. If the obstruction is a lead bullet it can be bored out with the drill.

In some cases, however, so much soft rag may be wedged into the bore that it has to be picked out. Take a steel rod of almost bore diameter, and cut a wood screw thread on one end about an inch long. Equip the opposite end with a large "T" handle. The rod is inserted at either end of the barrel (usually by the shortest route to the obstruction), and the rod rotated by means of the handle, at the same time applying pressure, so as to screw the rod a short distance into the obstruction. Then pull back on the rod and tear loose and pull out a small piece of the obstruction. Continue until it has all been removed.

Care should be exercised in driving the rods, and hard blows particularly should be avoided. Light blows with a hammer, in most cases, will start the obstruction. Heavy blows are apt to only wedge it tighter.

Do not use heat if it can possibly be avoided, as heat is liable to change the character of the steel, and ruin the barrel. In an obstinate case, however, where

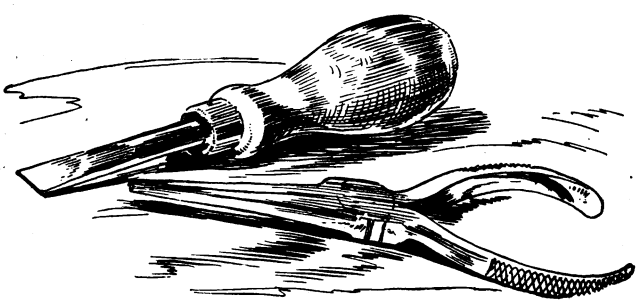
the barrel is going to be injured anyhow, heating the barrel at the point of the obstruction will expand the bore and loosen the obstruction, or will char the obstruction so that it can be removed.

It must be remembered, however, that in the large majority of cases an obstruction can be removed easily if it be soaked with oil and driven out with the square tip on the rod, and this is the safest method as injury to the barrel is not likely to result.

Once in a great while a cartridge case may rupture in the chamber of a rifle, and upon opening the action the head of the case will come out, leaving the neck, or the neck and a part of the body securely wedged in the chamber. Or the neck may even be carried a little distance into the rifling. Ruptures in cartridge cases are due either to too much head space in the chamber and breech bolt, or to defective brass in the cartridge case. Ruptures almost never occur in a properly made rifle using peace time ammunition, but are of somewhat frequent occurrence when ammunition made in war time is used. There are several broken shell extractors on the market, designed to remove cases which have broken and become wedged in the chamber. They all work on the same principle of entering the broken portion of the case, expanding therein, and having a head by which they can be pulled out with the broken case attached. In their absence the amateur can cut a thread on a steel rod the correct size to enter the case, screw it into the case, and then pull out the broken case with it.

In case the cartridge case breaks at the neck, and a portion of the neck is carried up into the rifling, it will be necessary to drive it out from the muzzle. This can usually be done with a square tip on the cleaning rod

as shown in Figure 28-B. Or, better still, a tip as shown in Figure 28-C, can be used. This latter tip is cut as a female to the rifling, a portion fitting down into the grooves, and the remainder riding on top of the lands. They can be procured for Springfield and Krag rifles, but will have to be made for other types and calibers of rifling. They are very handy in removing all kinds of obstructions from the bore as they fill the bore so completely that everything must be driven before them.



CHAPTER XI.

Lapping Rifle Barrels.

SOME rifle barrels can be considerably improved by proper lapping; that is, polishing with a mild abrasive and lead. For example, one may have a high-power barrel. It has the proper bore dimensions but there are many reamer marks running cross-ways of the lands, and these cause the barrel to pick up so much metal fouling that the barrel becomes a little inaccurate after the first twenty shots or so, and is extremely difficult to clean. These reamer marks that pick up the metal fouling can be largely eliminated by proper lapping. Then there is the barrel, either high or low power, which has a tight place in it, and which does not seem to shoot quite as well as it should. Before discarding it, try lapping out this tight place; it may make it into a gilt-edge tube. But don't get the idea that every barrel can be improved by lapping, because a first-rate barrel does not need it, cannot be improved by it, and may indeed be injured by injudicious lapping.

The first operation in lapping is to thoroughly clean the bore, using ammonia solution to clean it free from metal fouling if necessary. Then examine the bore from both breech and muzzle most carefully in a good light to determine the location of any rough places, reamer marks, and to impress on the eye its appearance at all points so you can judge how your work is progressing from time to time. Then measure the bore as described in a previous chapter, noting the groove and bore diameter, and the location of any tight or loose places. Mark any tight or loose places on the outside of barrel with chalk.

The tools necessary to properly lap out a barrel are, first of all, a suitable lapping rod. By "suitable" is meant one to lap out a rifle, and not an ordinary cleaning rod. The drawing (Figure 29) shows how this rod should be made. It is important that this rod be made of steel, equipped with a "T" handle big enough to be handled with both hands, and fastened to the rod with a double set of ball bearings. In addition there will be needed an ordinary melting pot of iron or a crucible for melting lead, a supply of lead, a few strands of cotton waste, a ladle with small spout which will pour lead in a small stream, a knife, and a small file. Finally, a supply of abrasive materials consisting of a light-bodied oil, flour of emery, fine crocus powder, and rotten stone.

The process of lapping out the barrel is one that will take at least three hours, and one had better count on taking from six to eight hours at it, going slow, and doing a good job. Once again the bore must be thoroughly clean before you start in. Brush it out, dope it with the metal fouling solution, dry and clean it most thoroughly, as a single lump of metal fouling or any foreign substance in the bore will tear a groove through the soft lead tap and possibly adhere to the lap and scratch the bore.

The lapping rod is first run through the barrel from the breech, and the tapered end of the rod allowed to project from the muzzle about four inches so as to expose the cannelures below the jagged tip. A layer or two of cotton waste, thread or similar material is then wrapped around the rod in the cannelures and the rod carefully withdrawn until the jagged tip is about two inches below the muzzle. The cotton waste is only to prevent the melted lead from running down the bore of the rifle.

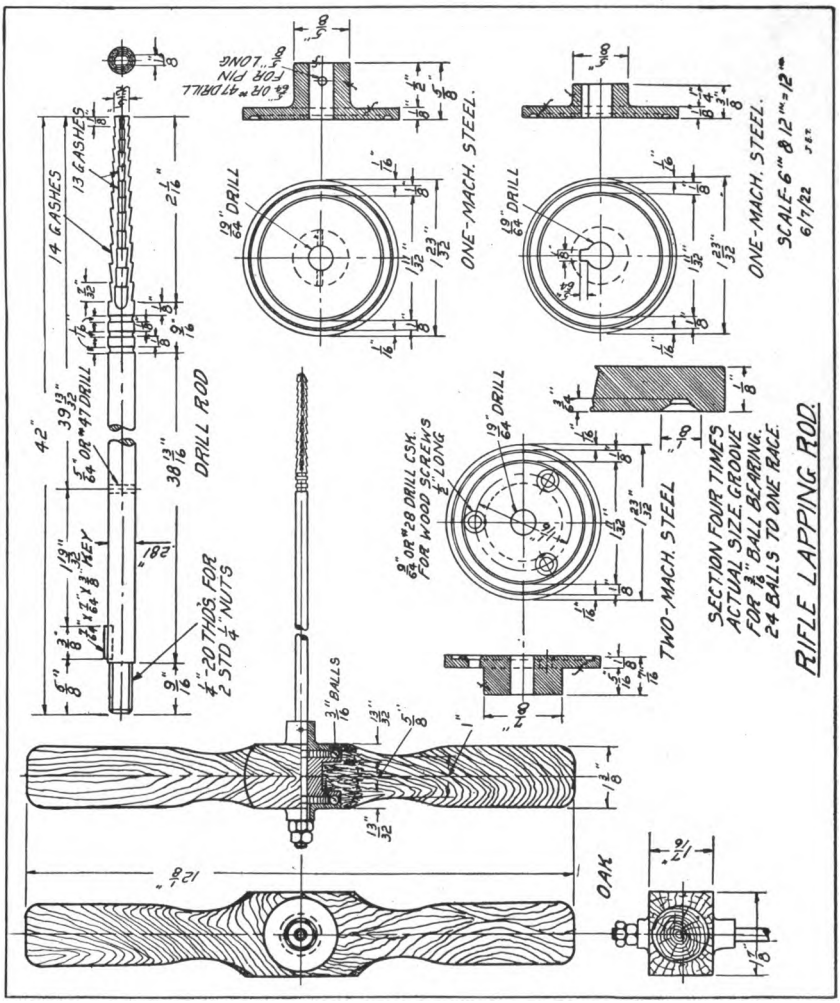


FIGURE 29.

Next heat the muzzle of the rifle slightly, down as far as the cotton waste, taking care, however, not to get too much heat such as would draw the color and consequently the temper of the barrel, or char the waste—say, not over about 250 degrees F. This is to prevent the lead shrinking excessively and to give a good, full and perfect lap. In the meantime, the lead has been melting in its pot. When the muzzle of the barrel has become warm enough secure it firmly in a vertical position (as in a vise), and carefully pour the melted lead in until it is flush with the muzzle. It is best to have some sort of a support at one side of the muzzle to rest the pot on while pouring, and thus insure a steady, thin stream of lead accurately entering the muzzle.

The lead will cool immediately, and the rod is then pushed forward in order that the lead lap formed by the casting may be examined. A word of caution is necessary at this point. At no time should the lead lap completely leave the bore. If this happens it should be melted off and a new lap cast. In case a cap of lead is noticed on the forward end of the lap, due to excessive casting and overflow of lead above the muzzle, this should be removed by whittling with a sharp knife, or filing off carefully. A satisfactory lap should show a full and perfect cast of the bore, the lands and grooves being sharply defined. A few small air holes are hard to avoid, but these should not be excessive or too large. Should the lap, when examined, be unsatisfactory, it is simply melted off by inserting the end of the rod in the melting pot and another cast as just described.

Having produced a satisfactory lap, the rifle is clamped securely in a heavy vise, which should be attached to a substantial work bench that will not move or vibrate. Have brass false jaws for the vise so that it will

not mar the barrel. The end of the lap is then shoved out the muzzle of the rifle so as to not quite expose the cotton wrapping around the cannelures of the rod. This cotton wrapping does not remain on the rod during the lapping, but is removed from the breech end at the first opportunity. The lap is now coated with a thin film of oil, and the lap worked up and down the bore a few times to smooth the lap and see that it functions properly, turning easily in the grooves. The ball bearings of the handle of the rod must work easily so that the lap will find no difficulty whatever in following the grooves, nor tend to bear unevenly or too hard on the driving sides of the lands. A wooden stop, well padded with felt or cloth, should be swung in place about an inch in front of the muzzle in order to eliminate the danger of shoving the lap completely through the bore and ruining it, but care must be taken that the lap is not bumped against this stop so hard as to expand the end of the lap. Also, the rod itself should be distinctly marked below the lap, this mark indicating where to stop when pulling the rod back towards the breech in order that the lap may not come out of the barrel at the chamber end.

The proper abrasive material to use on the lap depends upon the condition of the barrel and the exact results desired. Under normal circumstances the first abrasive should be the finest flour of emery. This should be mixed with the oil in the form of a paste that has about the consistency of thick cream, and should be applied evenly to the lap, the lap being exposed from the muzzle about two inches for this purpose. Flour of emery cuts very rapidly, and should not be used too long. The bore is lapped by taking hold of the "T" handle with both

hands, and with a steady motion draw the rod back to the mark at the breech which indicates that the lap has just reached the chamber, and then, with the same steady motion, push the rod forward until the lap almost touches the stop in front of the muzzle. In a barrel that has no tight or loose places in the bore, care should be taken that the lap is applied to the entire length of the bore in continuous, even strokes. If there are tight places in the bore, work over these first for fifteen or twenty strokes, then about fifteen or twenty more strokes, going over the tight place for one stroke, and the next stroke over the entire bore, and so on. Usually it can be told by the feel of the rod as it is pushed and pulled through the bore when these tight places disappear. From time to time the lap must be pushed out the muzzle sufficiently to allow more of the flour of emery paste to be applied.

It is not advisable to use the flour of emery too much at first, as it cuts very quickly. Generally speaking, about two to five minutes should not be exceeded at the start. Then the rod should be withdrawn from the barrel, the barrel thoroughly cleaned, first with gasoline, then with oil and patches, wiped dry, examined to see how far the reamer marks have been eliminated, and the bore should be again measured as described in a previous chapter, and these measurements compared with the previous measurements to see how far the cutting has progressed. Generally speaking, the flour of emery should not be continued so as to increase the measurements by more than .0001 to .0002 inch, particularly in a barrel to be used with jacketed bullets, although slightly more cutting than this is permissible in a barrel using only lead bullets. From this examination one can determine about how much of the flour of emery lapping it is safe to give the

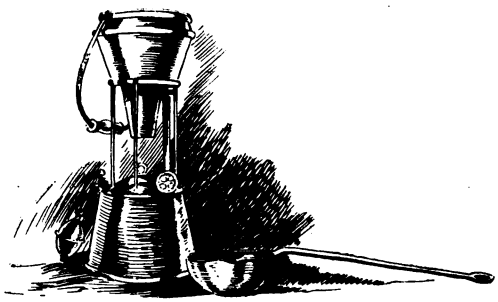
barrel. If more is necessary, another lap is cast, and one proceeds as before.

When the operator is satisfied that it is no longer desirable to continue with the flour of emery, the rod is again pulled completely out of the bore, the bore again cleaned absolutely free from emery, using gasoline and oil, a new lap is made, and the bore is again lapped with a paste of oil and fine crocus. The bore can be lapped with this fine crocus for two or three hours with profit, and then should follow a similar lapping with rotten stone and oil. The exact amount of time and effort with these two abrasives must be determined by the operator, but if ordinary precautions be taken, and the bore be frequently examined and measured, and the lap kept in good condition and renewed occasionally, it is hardly possible to lap too much, and there is absolutely no doubt as to the improvement resulting in the bore of the rifle. At the end of this treatment the tool and reamer marks should all have disappeared and the bore should have taken on an exceptionally high degree of polish.

The abrasives mentioned herein can be obtained from any large hardware store. Be sure that you get only the very finest flour of emery, and do not be satisfied with any coarser substitute, as coarser grades will scratch and ruin the bore.

It is a good idea to practice first on a barrel about which one does not care so much. For example, one may have an old barrel for the Krag rifle for which he does not care because it is considerably over the correct groove diameter; say .3095 inch instead of .308 inch, as it should be. This would be an excellent subject on which to practice, as one could lap it until it measured anywhere be-

tween .310 and .311 inch and then be able to get fine accuracy from it using bullets intended for the .303 British or the .303 Savage cartridges. Or an old .32-40 barrel may be used, these usually measuring about .3205 inch, and when lapped to .321 inch will be just right for the series of bullets designed for the .32 Winchester Special cartridge.



CHAPTER XII.

Field Repairs.

IN the field, the repairs that can be made to firearms are naturally limited by the tools available and by the ingenuity of the sportsman in applying the resources at hand. On a hunting trip there are certain things that everyone should carry. These include, of course, the outfit for the proper care of the weapons, such as cleaning rod, brass brush, oil, grease and flannel patches. The Government supplies for the Springfield rifle a small pocket screwdriver. This is strong and very light and one should always be carried. In addition, every hunting outfit except the very lightest should include a file, a small tool handle containing awls, gimlet, etc., a coil of copper wire, and a small box containing assorted nails, tacks and rivets. Of course, every outfit has a knife, axe or handaxe, and whetstone. Such an outfit need not weigh more than a few ounces, and can be wrapped up in a wiping rag. With it and a little Yankee ingenuity, it is wonderful what a man can do in the way of extemporized repairs.

One of the most serious, and at the same time most frequent accidents that can occur to a gun on a hunting trip is to have the stock break at the grip. Ordinarily, one would think that the weapon was completely out of commission until a new stock could be made, but cheer up, because such a break can be repaired in a couple of hours to be as strong as ever. Our Western pioneers were breaking their stocks in this manner all the time, and as it was impossible for them to exist hundreds of miles from

any supplies without a rifle, they quickly evolved a method of repair using rawhide. In fact, most of these mountain rifles had rawhide sewed and laced over the small of the stock to strengthen this part, and thus, to a certain extent, to forestall such an accident. Rawhide, made from the skin of any large animal, shrinks greatly as it dries and becomes as strong as iron.

If the stock has broken with a long, diagonal break, it can be simply wrapped and laced with rawhide, and when the hide dries it will be as strong as ever. To prepare the rawhide, take the hide of any animal, soak it in warm water for a few hours, perhaps adding some wood ashes to the water, and the hair will begin to slip. With the back of the hunting knife scrape and grain off the hair. From the edge of the hide cut thin thongs for lacings. Cut the hide to the correct shape and size so that it will wrap several times around the break and extend about four inches beyond the break on each side. Wrap it around as tight as possible and then sew it tight, using an awl and the rawhide thong. When the hide dries, which it will do overnight if placed in a dry place, the stock will be tightly and permanently bound together.

Sometimes the break is straight across the grip. In such a case a dowel pin is necessary. Point a nail at each end with the file, drill holes accurately opposite each other in the two pieces of stock, drive the nail into one of these holes, half way, and then drive the other piece of the stock on to the other end of the nail, so that the break meets accurately. Then wrap with rawhide.

One of my friends had his sporting Springfield rifle break at the grip on a hunting trip in Minnesota. Not having any rawhide, he inserted dowel pins made of ten penny nails. Then he took two table knives from the

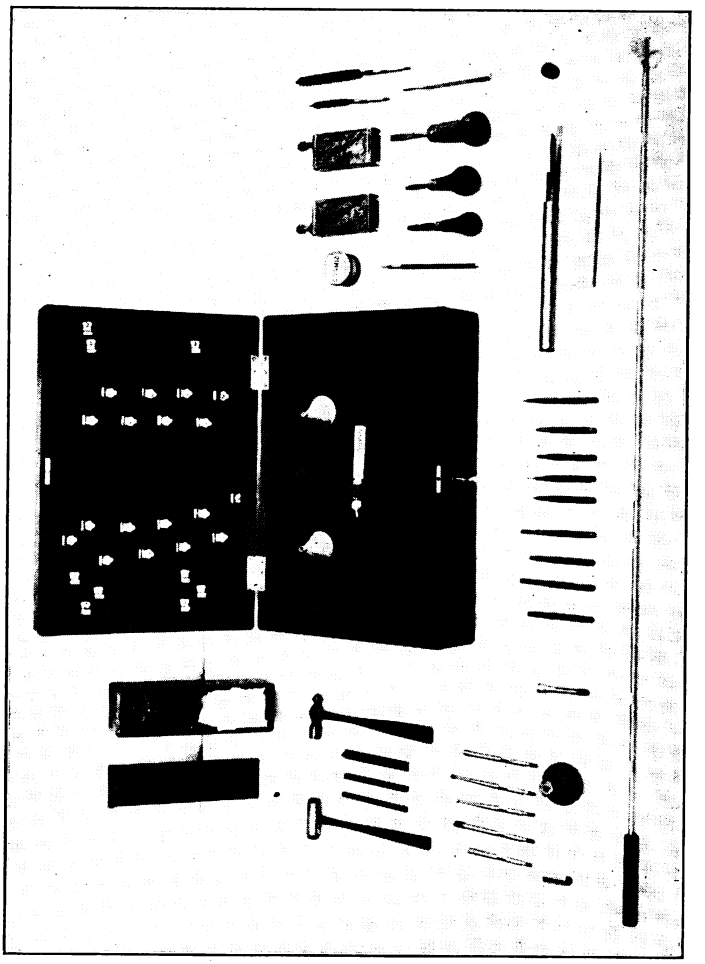


FIGURE 30.

De Luxe tool chest for cleaning and repairs.

cooking outfit, removed the handles, and filed off the guards, and proceeded to inlay these on either side of the break, so as to extend past the break. Small channels were cut for them in the stock with a knife. Then the whole was very tightly and heavily wrapped with fish-line, and was found to be as strong as ever.

Once I had the privilege of seeing a rifle belonging to an old African hunter. A fall had broken and splintered the forearm, but it had been very neatly repaired by putting the forearm back and pulling over it, as one would pull a stocking over a leg, the hide from the leg of an impalla. The hide had been skinned off of the leg without slitting it, and the hair left on. The fine, short haired, and fawn color skin looked very attractive over the forearm and barrel.

Another friend, Mr. Charles Sheldon, when hunting bear on Montague Island, off the coast of Alaska, had a most remarkable experience. He was climbing high up on one of the mountains on which he had seen a bear, and was just coming around a clump of bushes on a steep slope, when he ran smack-bang into a big bear coming hell bent for election in the opposite direction. The impact knocked Mr. Sheldon about twenty feet down the mountain side, and his rifle fell about fifty feet. When he picked the rifle up he found that the front sight had been knocked off of it. That night by the light of the camp fire he whittled out a new sight from a silver dollar, and the next day, after a few sighting shots, his rifle was as good as ever. I think that he got even with the bear by killing it a few days later.

We have learned so much in the last few years about the heat treatment and manufacture of steel that it is

extremely unlikely that any part of the mechanism of a modern arm will break. The old leaf springs have been largely replaced by coil springs which not only do not break, but do not lose their strength nearly as quickly as the leaf springs. About the only part of the mechanism that is at all likely to become unserviceable is the firing pin or striker. Sometimes these can be filed up out of a large nail, but it is far better to provide for such an emergency in advance, and get an extra firing pin, drill a recess in the stock under the butt-plate into which it will fit, place it in this recess, and then pour melted beeswax in on top. The pin will always be there, and all one needs is his pocket screwdriver to get at it by removing the butt-plate. An extra front sight, leaf for the rear sight, and a broken shell extractor should similarly be fitted into the stock. On the best English rifles there is usually a cavity in the end of the pistol grip containing extra striker and front sight, access thereto being through a little trap in the pistol grip cap. I do not like this scheme because the cavity weakens the stock at its weakest part. Better put them under the butt-plate. On lever action rifles it might be well to include an extractor as well.

The only time when my own rifle was placed hors-de-combat in the field was on one rainy day when hunting deer in the Santa Lucia Mountains in California. I fell on a slippery hillside and jammed the muzzle of the rifle deep into the mud, filling the bore with about eight inches of black mud. I climbed down to a little stream, cut a willow for a cleaning rod, and promptly got that rod stuck and broken off in the bore. I could do nothing with it until I got back to camp as the rifle

was a Winchester, Model 1895, and I could not dismount the breech block to push it out with another willow rod. Since then I have always carried with me when hunting a pocket steel cleaning rod, having thin joints six inches long. It weighs only four ounces, and twice it has paid for itself in letting me clean the bore when hunting where otherwise I would have had to terminate my hunt for the day and go back to camp for the big rod.

On my last hunting trip my companion had the misfortune to lose the gold bead out of his front sight. This, by the way, in many years of experience, is the first time I have known a sight to lose its bead, which speaks for the fine workmanship and strength of Lyman, Marble, and King front sights. With a pen-knife, and the file we had brought along to sharpen the axe, I made a new bead from a ten cent piece and hammered it into place, levelling the surface towards the eye slightly so that it reflected the light from the sky. It worked splendidly for a few days until it fell out. In all, we had to make three beads for that front sight during the trip. All this would have been avoided had we carried an extra front sight in the stock of the rifle.

Of late years I have been removing the pin which secures the front sight blade to the movable base of my Springfield and similar rifles, and substituting for it a small screw. This makes it easy to replace front sight blades without the bother of driving out the pin. Driving out these small pins is always difficult if one does not have the correct drift pins, a hammer, and a vise at hand. In the field a substitute for a drift pin can be made by filing down a wire nail, then heating it red hot and plunging it into water. In driving out a front sight or its pin be sure that the muzzle of the rifle is well sup-

ported against the blows of the camp axe by placing it against a stump, as it is very easy to bend a rifle barrel by striking it near the muzzle when it is unsupported. Another advantage of a screw instead of a pin is that one may have both gold and ivory bead front sights and jack sights for various kinds of hunting, and also a flat top military steel sight for target practice, all of the same height, and they can be interchanged easily in a minute or two.

A field repair kit is a very handy thing for a rifleman to have. This may be nothing more than a little roll of canvas holding the most essential tools for an emergency, and light and compact enough to take on a hunting trip where weight and bulk must be avoided. Or it may be made up with a view to using it at home, and of taking it to the range or to the National Competitions or Grand American Handicap. There is a chance for a lot of ingenuity in getting up such a kit, and the container for it.

Many years ago each company in the Regular Army had what was known as a Company Repair Kit. It consisted of a neat little wood box about 14″x10″x4″, and it contained hammer, screw-drivers of different sizes, a complete assortment of drift pins, a number of spare parts for the rifle, a small anvil, and a device for repairing the snap buttons on cartridge belts. A number of riflemen saw the possibilities of these kits, purchased them while they were still available, discarded the articles they did not require, and filled them up with their own selection of tools. With such a kit there is almost nothing in the way of repairs that a handy man cannot do for himself and friends at home or on the rifle range. The following is a list of some of the articles that such a chest might contain.

Small pene hammer.
Light brass hammer.
Small bench vise.
Small hand vise.
Handy tool handle containing awls, screwdrivers, gimlets, gonges, chisels, etc.
Files—flat, half-round, and saw.
Screwdrivers, very small.
Drift pins, assorted sizes.
Brass rod for driving out sights.
Oilstone, large.
Oilstone, slips, for lightening trigger pulls.
Trigger pull weight.
Jewelers files, assorted, rat-tail, half-round, square, triangular, etc., for dressing out apertures and sight notches.
Broken shell extractors.
Small reamers for peep sights.
Barrel gauges.
Micrometer calipers 1 inch.
Steel rule, 12 inch.
Lead bullet for calibrating rifles.
Drill for removing obstructions from bore.
Scissors.
Kit knife.
Leather punch for sling holes.
Brass bristle brushes, assorted sizes.
Jointed cleaning rods.
Cut flannel cleaning patches.
Rust remover.
Can of gun grease.
Can of gun oil.
Funnel for water cleaning.
Emery paper.
Sand paper.
Valve grinding compound.
Needles and thread.
Spare parts, such as: Front sights, strikers, firing pins, sears, extractors, ejectors, pins, and screws.
Assorted nails, screws, tacks, brass wire, sheet brass, etc.
Copy of "AMATEUR GUNSMITHING."

APPENDIX A

Removal of Metallic Fouling

The amateur gunsmith may frequently be called upon to remove metal fouling from the bores of rifles belonging to his friends, or even his own. This requires a special process. Also, this process used for the removal of metal fouling is the very safest way to clean a rifle if it is to be placed in storage for a long time, or if it is to be shipped a long distance to its owner after having been fired for testing and sighting in.

Metal fouling consists of flakes or smears of cupro-nickel from the jackets of the bullets, and most frequently occurs when high velocity rifles are fired with ammunition loaded with bullets having cupro-nickel jackets. To determine if it be present, the bore should first be thoroughly cleaned and dried, but not oiled. The breech should then be held up to a good light and the bore examined from the muzzle end. Look particularly at the top of the lands for about eight inches down from the muzzle. If the bore be metal fouled one will see small specks, flakes, lumps, or smears of metal adhering to the lands, and sometimes in the grooves. They appear as flakes or lumps of lead, apparently about half as thick as the lands are high. If this kind of fouling is found it should be removed at once, as it will interfere with accuracy, and the bore may become seriously rusted under the flakes. To remove it, proceed as follows:

The bore should be made as clean as possible, but should have no trace of oil or grease in it. It is best to clean it with water and a brass wire bristle brush, and then to dry it. Place a rubber cork of the proper size in the chamber, so as to completely seal the bore at the breech and make it water tight. Place a rubber tube over the outside of the muzzle, this tube to be about 2 inches long, and to extend about half an inch beyond the muzzle, making a water-tight joint at the muzzle. Stand the rifle in a rack, muzzle up and barrel vertical. Make up some of the following standard metal fouling solution:

Ammonium persulphate	½ ounce.
Ammonium carbonate	100 grains.
Stronger ammonia, 26 to 28%	3 ounces.
Distilled water	2 ounces.

The first two ingredients should be powdered together in a small mortar and pestle, and mixed with the latter two ingredients. Stir a little, and when all the powder has been dissolved

the solution is ready for use. The above amount is sufficient to clean three barrels of .30 caliber. It is best kept by placing in a bottle with a tight rubber cork, like the bottles that druggists usually sell citrate of magnesia in. Do not fill the bottle more than two-thirds full, as the solution generates a powerful gas, which might blow the cork out or burst the bottle. Keep it in a cool place. The solution will keep all right for two or three weeks, but after that it is likely to become dangerous, in that it may rust steel. Use freshly mixed solution where possible. Keep the bottle tightly corked except for the few seconds necessary to pour out the amount required. The ingredients can be obtained from any large drug store or from drug supply houses. Small druggists often do not know what the ingredients are.

Carefully pour this solution into the muzzle of the rifle, through the rubber tube, until the bore is full and the liquid rises in the rubber tube. Take extreme care not to spill any on the outside of the rifle, and if you do so spill it, wipe it dry at once. Let this solution remain in the bore from fifteen to thirty minutes, never more than half an hour under any circumstances. When first placed in the bore it is colorless like water, then it will begin to bubble a little, and soon assumes a deep blue color as it dissolves the cupro-nickel and copper. It probably performs all its work in the first ten minutes. After the specified time reverse the muzzle down, and pour out the solution. Still keeping the muzzle down, remove the tube of rubber from the muzzle, and insert a cleaning rod up from the muzzle and drive out the cork from the chamber. Keep the muzzle down all this time, so that none of the solution can flow back into the chamber and mechanism and cause rust. Now, with the cleaning rod, run one flannel patch completely through the bore from breech to muzzle, thus pushing out any solution that might remain in the bore. Then every trace of ammonia should be removed from the bore at once before it has had a chance to evaporate thereon. The best way to accomplish this is to run water through the bore from breech to muzzle by means of a funnel and rubber tube, and then dry the bore thoroughly with dry, clean flannel patches on a clean cleaning rod. Then look through the bore to see that it is perfectly clean and free from metal fouling. If the bore appears perfect it only remains to give it a thorough swabbing and coating with any good gun grease or cosmic, and set it away. It will then be perfectly clean and protected, and can be stored for a long

time, or shipped to a distance with a surety that it will remain in perfect condition.

If, however, on looking through the bore some metal fouling still remains, run a brass bristle brush through the bore several times, being sure that the brush is clean and free from oil or grease, and again apply fresh solution in the same manner. Generally one application is all that is necessary to free the bore completely from metal fouling, but obstinate cases have been known, or cases where there was so much fouling that it took three or four applications.

Cautions and Suggestions.—So long as the ammonia retains its strength, and the steel remains wet with it, it will have no action whatever on the steel. If, however, it is allowed to evaporate on the steel, the steel will rust very quickly. If the solution be permitted to stand for a long time exposed to the air the corbonate will evaporate and the remaining solution will rust steel rather quickly. Hence the precautions about keeping the bottle tightly corked, not spilling any over the rifle or in the mechanism, and putting a rubber tube over the muzzle so that none will evaporate on the steel at the muzzle of the rifle while being applied. The ammonia will also take the varnish and finish off the stock of the rifle very quickly if spilled thereon.

Never pour the solution into a barrel that is still warm from firing, for it will completely ruin the barrel in about three seconds. Always let the barrel cool before applying this treatment.

If metal fouling has to be frequently removed it is very convenient to have a small glass vial which will hold just enough solution to completely fill the bore, thus obviating the danger of spilling by overflowing, and making the pouring easier and quicker. In the absence of a mortar and pestle the persulphate and carbonate may be powdered by placing within a fold of clean cloth, and pounding with a hammer. If, before pouring the solution into the bore, a *steel* cleaning rod be placed in the bore (taking great care not to drive out the cork in the chamber) only about one-fourth the amount of solution will be required to fill the bore, and as the solution is rather expensive, this is quite an item. The action with the steel rod in the bore is just as quick and complete as without it, and the rod is not injured if wiped off afterwards.

The presence of oil or grease will saponify the ammonia and prevent its dissolving the metal fouling.

Used exactly as described, this standard metal fouling solution is perfectly safe and effective.

APPENDIX B

Making Sulphur Casts of Rifle Chambers

In order to measure the chamber of a rifle accurately it is necessary to make a cast of it. This cast is best made of sulphur. The chamber and about half an inch of the rifling in front of the chamber should be thoroughly cleaned, and should then be given a very slight film of light oil. A core the size of the bore of the rifle has a small hole drilled in its exact center, into which the end of a wire, about .0625-inch, will fit. The wire functions as a handle for the cast. It extends through the cork, is clinched on the forward end of the cork, and its rear end extends back of the chamber to form a handle. Press the cork with wire attached to a point in the rifling about half an inch ahead of the chamber.

The mixture is to be made from the following materials:

Sulphur .....2 ounces.
Powdered lampblack .....3 grains.
Gum camphor dissolved in alcohol .....3 drops.

Heat very slowly and stir continually. When the mixture arrives at a thin pouring consistency it is ready to pour. With muzzle downward, pour the mixture into the chamber quickly, and allow it to thoroughly cool before removing the cast. To remove the cast introduce a cleaning rod into the muzzle and shove lightly, holding the cast by the wire handle as it comes out. Then measure the cast within the next few minutes, as it may shrink slightly if left for some time, although the above mixture shrinks less than many others.

The cast must be handled very gingerly, as it is extremely brittle. It is very important that the mixture be heated *slowly*, otherwise it becomes too thick to pour. The quantity given above will make two casts of a .30 caliber chamber.

APPENDIX C

Method of Dismounting Krag Breech Action

To Remove the Bolt.—Draw the bolt fully to the rear, then place the rifle across the hollow of the left arm. Lift the front end of hook of extractor off bolt with left thumb, and at the same time turn bolt handle to the left with right hand. The bolt can then be drawn from the receiver.

To Dismount Bolt Mechanism.—Take bolt in left hand, back of hand down, bolt upside down. Grasp cocking piece with right hand, slightly draw back cocking piece and turn it towards the operator until the firing pin can be removed from the bolt. Take firing pin in left hand and bear down on point of striker with right thumb until it leaves the firing pin; remove mainspring from firing pin and the latter from sleeve.

To Assemble Bolt Mechanism.—Observe that the safety lock is turned to the left. Reverse the steps of dismounting striker and firing pin. Insert firing pin in bolt. Grasp handle of bolt with fingers of both hands, bolt directly downward, and with both thumbs on rear of safety lock, push strongly forward and turn to right with thumbs until the arm of the sleeve engages the collar of the bolt. Draw back and turn cocking piece from the operator until its nose enters the notch on rear of bolt. Take the bolt in right hand, bolt handle up, and insert it in receiver, keeping the extractor lifted with right thumb. Turn the bolt handle to the right and at the same time press strongly with first finger against right side of extractor, forcing extractor into its place.

To Dismount Magazine Mechanism.—The magazine gate being closed, engage the flanged head of a cartridge case under the lug on the front end of the hinge bar head, and turn the latter towards the gate, out of its seat; then bear heavily on the gate with palm of right hand to overcome the pressure of the magazine spring, and, with left hand, press forward against the lug, drawing out the hinge bar pin. Remove the gate, magazine spring, carrier and follower.

To Assemble Magazine Mechanism.—Hold rifle with right side uppermost. Insert arbor of carrier in its hole in receiver and place end of left thumb across magazine to prevent carrier swinging into the latter. Place magazine spring in its channel, convex side up, rounded end to the rear, particularly observing

that the lip at its front end rests in the notch on heel of carrier. Place gate in its seat, lug entering between carrier and magazine spring. Remove left thumb and at the same time press gate against magazine spring with right hand. Insert hinge bar pin in front hinge hole in receiver with left hand, and press gate down strongly until the pin can be pushed through gate into rear hinge hole. After the hinge hole is fully home, turn the head into its seat by opening the gate.

To remove safety lock, turn it vertical and strike front face of its thumb piece a light blow. To assemble, introduce the point of the tang of a small file, or any tool of similar size and shape, between the thumb piece and the spring spindle, thus compressing the spring and forcing the spring spindle into the thumb-piece; insert the safety lock spindle in its hole in the sleeve, the thumb-piece being held vertical, push the safety lock forward, gradually withdrawing the tool.

APPENDIX D

Method of Dismounting Mauser Breech Mechanism

Cock the rifle by raising and lowering the bolt handle, and turn the safety lock to a vertical position. Open the bolt and pull it to the rear with the right hand, at the same time holding the bolt stop (on left rear of receiver) out to the left. The bolt can then be withdrawn from the receiver.

To further dismount the bolt: Press backward on the bolt lug stop on the left side of the sleeve, and at the same time unscrew the sleeve with cocking piece and firing pin from the bolt proper. Grasp the sleeve (sleeve is piece carrying safety and surrounding firing-pin rod) with left hand, thumb pressing down on finger piece of safety. In this position press point of striker firmly against piece of hard wood until mainspring is fully compressed and sleeve is lowered so that the end of the firing pin rod (cocking piece) is clear of its groove in the sleeve. Give the cocking piece a quarter turn, which will free it from the firing-pin rod. The firing pin, mainspring, sleeve, and cocking piece can then be dismounted. To remove the safety lock from the sleeve, turn the finger-piece of the safety to the right and pull it out of position. The assembling of the various parts of the bolt is simply done in the reverse order, taking care that the safety stands at a vertical position as soon as the firing-rod pin and cocking piece have been assembled to the sleeve. Be sure that the sleeve is screwed completely home in the bolt proper, otherwise the striker cannot reach the primer.

The magazine floor plate is removed in various ways, according to the type of floor-plate catch used, but the method will be perfectly apparent on examination. The floor plate having been removed, it is only necessary to slide the magazine spring out of its grooves in the floor-plate and the follower to dismount these parts. The extractor is removed from the bolt proper in the same way as prescribed for the Springfield rifle.

APPENDIX E

Method of Dismounting Mannlicher-Schonauer Breech Mechanism

The bolt is opened and drawn out of the receiver, the bolt-catch on the left rear of the receiver being simultaneously pressed in. The bolt is then taken in the left hand and is held so that the firing-pin nut stands upward. The firing-pin spring then has its stress released slowly by turning the cocking piece; the flag-shaped handle of the safety lock is pressed against the cocking piece and is turned from left to right through 180 degrees; the firing-pin nut is turned to the left through 90 degrees and is drawn off the end of the firing-pin. The flag-shaped handle of the safety lock is then again turned to the left, and the cocking piece removed, together with the safety lock. After this the bolt-head is turned to the left until the ejector and bolt handle stand in line. The bolt-head and firing-pin, pressed out of the bolt by the force of its spring, can now be removed. In assembling the bolt the same procedure is followed in the reverse order.

In order to remove the magazine, the cover-plate on the under side of the rifle is turned until it leaves its grooves in the body. To release the cover-plate for the purpose of turning it, press into the hole with the point of a bullet, thus compressing the flat spring which holds the cover-plate in place. The entire magazine can then be withdrawn downward out of the receiver. To replace, simply reverse the operation.

APPENDIX F

Dismounting and Assembling Other Rifles

Instructions for dismounting and assembling other American rifles will be found in full detail in the catalogues of the manufacturers. Be sure to obtain the larger catalogues, and not the abbreviated edtions used for general distribution.

Instructions for dismounting and assembling the U. S. Rifle, Caliber .30, Model of 1903 (Springfield), together with a full description of this rifle, its various parts, operation, care, and tables of fire will be found in a pamphlet entitled "Training Regulations No. 320-10, War Department, Washington, March 12, 1924, Weapons. United States Rifle, Caliber .30, Model of 1903, Accessories and Appendages." This pamphlet can be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at ten cents per copy, stamps not accepted. Every amateur gunsmith and every rifleman should have a copy of this pamphlet. It is indispensable to anyone who shoots or does any work with the Springfield rifle.

APPENDIX G

Usual Specifications and Dimensions of Rifle Barrels.

CALIBER	Twist of Rifling	Bore Diameter		Groove Diam.	
		Min.	Max.	Min.	Max.
	Inches	In.	In.	In.	In.
.22 Short	20	.2170	.2175	.2220	.2238
.22 Long Rifle	16	.2179	.2175	.2220	.2238
.22 W. R. F.	14	.2195	.2200	.2255	.2260
.22 W. C. F.	16	.2190	.2195	.2240	.2245
.22 Savage H. P.	12	.2200	.2205	.2260	.2265
.25-20 W. C. F.	14	.2500	.2505	.2570	.2575
.25-35 W. C. F.	8	.2500	.2505	.2570	.2575
.25 Rem. Auto	10	.2500	.2505	.2570	.2575
.250-3000 Savage	14	.2500	.2505	.2570	.2575
6.5 mm. Mannlicher	7.5	.2550	.2560	.2630	.2640
7 mm. Mauser	8.66	.2756	.2775	.2854	.2874
.275 Magnum, Hoffman	10	.2760	.2767	.2845	.2855
.280 Ross	8.66	.2810	.2820	.2890	.2900
.30-30 W. C. F.	12	.3000	.3005	.3080	.3085
.30 Rem. Auto	12	.3000	.3005	.3080	.3085
.30-40 Krag	10	.2999	.3020	.3080	.3110
.30 Mod. 1906 Govt.	10	.2999	.3005	.3080	.3090
.30 Magnum, Hoffman.	12	.2998	.3001	.3080	.3085
.303 Savage	10	.3000	.3005	3080	3090
303 British	12	3030	3040	.3120	.3140
.32-20 W. C. F.	20	.3050	.3055	3110	3115
.32-40 W., M. & S.	16	.3150	.3155	.3200	.3205
.32 Win. Special	16	.3150	.3155	.3200	.3205
.32 Rem. Auto	14	.3110	.3115	.3190	.3195
.33 W. C. F.	12	.3300	.3305	.3380	.3385
.35 Rem. Auto	16	.3480	.3485	.3560	.3565
.35 W. C. F. Model 95	12	.3500	.3505	.3580	.3585
.35 Whelen	18	.3500	.3503	.3570	.3575
.35 Magnum, G. & H.	18	.3500	.3503	.3570	.3575
.38-40 W. C. F.	36	.3940	.3945	.4000	.4005
.38-55 W., M. & S.	18	.3730	.3735	.3790	.3795
.375 Magnum, Hoffman	14	.3670	.3680	.3750	.3760
.400 Whelen	14	.4018	.4022	.4105	.4115
.404 Magnum, Hoffman	14	.4135	.4145	.4230	.4240
.405 W. C. F.	14	.4050	.4055	.4130	.4135
.44-40 W. C. F.	36	.4225	.4230	.4285	.4290
.45-70 U. S. Govt.	22	.4500	.4510	.4570	.4580
.505 Gibbs, Hoffman	16	.4945	.4955	.5045	.5055

APPENDIX H

Table Showing The Number of Thousandths of an Inch in 8ths, 16ths and 32ds of an Inch.

8ths		32ds	
1/8 equals	.125	1/32 equals	.0312
1/4 equals	.250	3/32 equals	.0937
3/8 equals	.375	5/32 equals	.1562
1/2 equals	.500	7/32 equals	.2187
5/8 equals	.625	9/32 equals	.2812
3/4 equals	.750	11/32 equals	.3437
7/8 equals	.875	13/32 equals	.4062
		15/32 equals	.4687
16ths		17/32 equals	.5312
1/16 equals	.0625	19/32 equals	.5937
3/16 equals	.1875	21/32 equals	.6562
5/16 equals	.3125	23/32 equals	.7187
7/16 equals	.4375	25/32 equals	.7812
9/16 equals	.5625	27/32 equals	.8437
11/16 equals	.6875	29/32 equals	.9062
13/16 equals	.8125	31/32 equals	.9687
15/16 equals	.9375		

Table Showing Equivalents of Millimeters and Inches.

1 mm equals	.03937 inch	14 mm equals	.55118 inch
2 mm equals	.07874 inch	15 mm equals	.59055 inch
3 mm equals	.11811 inch	16 mm equals	.62992 inch
4 mm equals	.15748 inch	17 mm equals	.66929 inch
5 mm equals	.19685 inch	18 mm equals	.70866 inch
6 mm equals	.23622 inch	19 mm equals	.74803 inch
7 mm equals	.27559 inch	20 mm equals	.78740 inch
8 mm equals	.31496 inch	21 mm equals	.82677 inch
9 mm equals	.35433 inch	22 mm equals	.86614 inch
10 mm equals	.39370 inch	23 mm equals	.90551 inch
11 mm equals	.43307 inch	24 mm equals	.94488 inch
12 mm equals	.47244 inch	25 mm equals	.98425 inch
13 mm equals	.51181 inch	1/2 mm equals	.01969 inch

10 Millimeters equals 1 Centimeter equals..... 0.3837 inch

10 Centimeters equals 1 Decimeter equals..... 3,937 inch

10 Decimeters equals 1 meter equals.....39.37 inch

25.4 Millimeters equals 1 inch.

WEIGHTS

Avoirdupois Weight—16 drachms equals 1 ounce, 16 ounces equals 1 pound.

Troy Weight—24 grains equals 1 pennyweight, 20 pennyweights equals 1 ounce, 12 ounces equals 1 pound.

Apothecaries' Weight—20 grains equals 1 scruple, 3 scruples equals 1 drachm, 8 drachms equals 1 ounce, 12 ounces equals 1 pound.

The Grain Weight—is the same in all tables. Powder is bought by Avoirdupois weight, but in weighing it for rifles and shotguns, Apothecaries' weight is used. There are 7000 grains Troy or Apothecaries' weight in 1 pound Avoirdupois.

One Drachm or Dram—Avoirdupois (shotgun measurement) is equal to 27.3437 grains Troy (rifle measurement).

APPENDIX I.

DIRECTORY.

1. American.

BAKER GUN CO. (Shotguns),
253 Church Street, New York, N. Y.

BELDING & MULL (Telescope sights, cleaning rods, bullet moulds, reloading tools, etc.),
Philipsburg, Center County, Penna.

MODERN BOND COMPANY (Reloading tools),
Wilmington, Del.

DIRECTOR OF CIVILIAN MARKSMANSHIP (Govt. arms),
War Department, Washington, D. C.

COLTS PATENT FIRE ARMS MFG. CO. (Revolvers, pistols),
Hartford, Conn.

E. I. DUPONT DE NEMOURS & CO. (Powder, explosives),
Wilmington, Del.

A. H. FOX GUN COMPANY (Shotguns),
4648 North 18th Street, Philadelphia, Pa.

GRIFFIN AND HOWE, INC. (Fine rifles, shotguns),
234 East 39th Street, New York, N. Y.

C. T. HARNER (Walnut stock blanks),
117 N. Isabella Street, Springfield, Ohio.

HERCULES POWDER CO. (Powder, explosives),
Wilmington, Del.

HOFFMAN ARMS COMPANY (Fine rifles, shotguns),
1762 East 27th Street, Cleveland, Ohio.

HUNTER ARMS COMPANY (Smith shotguns),
Fulton, New York.

ITHACA GUN COMPANY (Ithaca shotguns),
Ithaca, New York.

IVER JOHNSON'S ARMS & CYCLE WORKS (Firearms),
13 River Street, Fitchburg, Mass.

JOSTAM MFG. CO. (Rubber recoil pads and butt-plates),
5252 Broadway, Chicago, Illinois.

D. W. KING (Rifle sights),
Ball Building, San Francisco, Calif.

LEFEVER ARMS CO. (Shotguns),
Ithaca, New York.

LYMAN GUN SIGHT CORP. (Rifle sights),
Middlefield, Conn.

MARBLE ARMS & MFG. CO. (Sights, cleaning rods, accessories),
Gladstone, Mich.

NATIONAL RIFLE ASSOCIATION,
1108 Woodward Building, Washington, D. C.

R. NOSKE (Telescope sight mountings),
35 Montgomery Street, San Francisco, Calif.

P. J. O'HARE (Rifleman's supplies),
178 Littleton Avenue, Newark, N. J.

PARKER BROTHERS (Shotguns),
Meriden, Conn.

PETERS CARTRIDGE CO. (Ammunition),
Cincinnati, Ohio.

REMINGTON ARMS CO. (Rifles, shotguns, ammunition),
25 Broadway, New York, N. Y.

SAVAGE ARMS CORP. (Rifles, shotguns, ammunition),
Utica, New York.

SCHOVERLING, DALY & GALES (Gunsmiths' materials, sport goods),
302 Broadway, New York, N. Y.

SMITH & WESSON (Revolvers, pistols),
Springfield, Mass.

J. STEVENS ARMS & TOOL CO. (Rifles, shotguns, telescope sights, pistols),
Chicopee Falls, Mass.

R. D. TAIT (Walnut stock blanks, Springfield stocks),
Montague, Calif.

UNITED STATES CARTRIDGE CO. (Ammunition),
Lowell, Mass.

WESTERN CARTRIDGE COMPANY (Ammunition),
East Alton, Illinois.

WINCHESTER REPEATING ARMS CO. (Rifles, shotguns, ammunition),
New Haven, Conn.

2. English.

THOMAS BLAND & SONS,
2 King William Street, Strand, London, W. C. 2.

B. S. A. GUNS, LTD.,
Birmingham.

COGSWELL AND HARRISON,
168 Piccadilly, London, S. W. 1.

WILLIAM EVANS,
63 Pall Mall, London, S. W. 1.

GEORGE GIBBS,
39 Corn Street, Bristol.

STEPHEN GRANT & SONS,
67a St. James Street, London, S. W.

W. W. GREENER,
29 Pall Mall, London, S. W. 1.

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JAS. WOODWARD AND SONS,
64 St. James Street, Pall Mall, London, S. W.

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Vickers House, Broadway, London, S. W. 1.

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